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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 46227, 46307, 46459, and 46551.

Chemical and Spectral Procedures

Refer also to abstracts 46241, 46291, 46774, and 47808.

46167 (BARC–464) ESTIMATION OF PLUTONIUM BY CHEMICAL ANALYSIS. A Summary of the Work Carried Out at Fuel Reprocessing Division and Radiochemistry Division. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 39p. Dep. CFSTI (U. S. Sales Only).

A program of work on the standardization and application of some of the chemical methods for the accurate estimation of plutonium in PuO_2 and similar materials was undertaken. By use of the coulometric and volumetric estimation methods standardized at the Fuel Reprocessing Division (FRD) and the potentiometric titration method standardized at the Radiochemistry Division (RCD), more than 150 PuO_2 samples supplied by FRD were analyzed with a precision of better than 0.2%. The accuracy of the estimation methods was checked by using pure anhydrous $Pu(SO_4)_2$ prepared at RCD, as a primary standard. (auth)

46168 (BARC–470) A SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF EUROPIUM AND YTTRIUM IN RARE EARTH MIXTURES. Grampurohit, S. V.; Bagal, R. K. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 10p. Dep. CFSTI (U. S. Sales Only).

A dc arc method is described for the estimation of europium and yttrium in rare earth mixtures. The sample is diluted with cerium oxide, zinc oxide, and graphite in the ratio 1:1:4:4 and 15 mgs of this mixture is taken in the cavity of a ¼-in. graphite electrode and arced at 6 amps. Using a large quartz spectrograph, the spectra are recorded in the region 2300 to 3300 Å. Cerium is used as internal standard, and the intensity ratios of Y 2422.2 Å/Ce 2464.36 Å and Eu 2638.76 Å/Ce 2651.01 Å are measured. The ranges of concentration covered are 0.05 to 2% for europium and 1 to 50% for yttrium. (auth)

46169 (BARC–471) SPECTROGRAPHIC DETERMINATION OF RARE EARTH IMPURITIES IN ERBIUM OXIDE AND YTTERBIUM OXIDE. Grampurohit, S. V.; Swamy, K. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 11p. Dep. CFSTI (U. S. Sales Only).

A spectrographic method is described for the estimation of dysprosium, holmium, thulium, and ytterbium in pure erbium oxide and lutetium, erbium, and thulium in pure ytterbium oxide. A Jarrell Ash grating spectrograph and a dc arc excitation method are employed for the estimation of the impurities in the following concentration ranges: Dy 0.005 to 0.5%, Tm, 0.005 to 0.5%, Ho 0.025 to 0.5%, and Yb 0.0025 to 0.05% in Er_2O_3; and Er 0.005 to 0.05%, Tm 0.005 to 0.1%, and Lu 0.035 to 0.5% in Yb_2O_3. (auth)

46170 (BARC–472) DETERMINATION OF RARE EARTH IMPURITIES IN PURIFIED LANTHANUM OXIDE USING THE STALWOOD JET. Grampurohit, S. V.; Bellary, V. P. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 8p. Dep. CFSTI (U. S. Sales Only).

A dc arc method is described for the estimation of Ce, Pr, and Nd in purified lanthanum oxide. The spectra are excited at 8.0 A by means of a Stallwood jet with oxygen atmosphere and recorded in the second order of a 1200 grooves/mm grating on a 3.4-meter Jarrell Ash grating spectrograph. The detection limits attained are 0.003% for Ce, 0.002% for Pr, and 0.001% for Nd. (auth)

46171 (BARC–486) SPECTROGRAPHIC ANALYSIS OF PURE BISMUTH. Saranathan, T. R.; Ayyar, K. Harihara (Bhabha Atomic Research Centre, Bombay (India)). 1970. 8p. Dep. CFSTI (U. S. Sales Only).

A spectrographic method is described for the analysis of bismuth oxide and metal for a number of impurities. The powdered sample is mixed with graphite in the ratio 5:1 by weight and 25 mg of the charge is arced at 10 amps dc. The spectra are photographed using the Ebert 3.4-meter grating spectrograph with a 15,000 lpi grating set in the second order for 2250 A to 3500 A region. Chromium, incorporated in the graphite, is used as the internal standard. The detection limit ranges between 0.1 and 10 ppM for various elements and the precision of the method is about ± 20% (auth)

46172 (BARC–495) SPECTROGRAPHIC ANALYSIS OF NIOBIUM OXIDE: AN INTERMITTENT A.C. ARC METHOD. Chandola, L. C.; Karanjikar, N. P. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 13p. Dep. CFSTI (U. S. Sales Only).

A spectrographic method is described for the analysis of niobium oxide. The sample is glued to the flat ends of a pair of graphite electrodes and excited by means of an intermittent ac arc. The resulting spectrum is photographed on Ilford N.30 plates using a JACO 3.4-meter Ebert grating spectrograph having a 1200 grooves per millimeter grating in the first order. The analysis lines used are Ta 2685.1 Å, Fe 2598.4 Å, Mn 2605.7 Å, Mo 2816.2 Å, Pb 2833.1 Å, Sn 2863.3 Å, and Ti 3078.7 Å. A matrix line Nb 2682.8 Å served as an internal standard. Tantalum is estimated up to a lower limit of 100 ppM with a precision of ±11%. (auth)

46173 (BARC–496) SPECTROGRAPHIC ANALYSIS OF LITHIUM FLUORIDE. A. DETERMINATION OF Cu, Cr, Mn, Mg, Ni, Ti, AND Pb. B. DETERMINATION OF Na, K, AND Ca. Chandola, L. C.; Rao, A. S. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 11p. Dep. CFSTI (U. S. Sales Only).

The following two complementary methods are described for the spectrographic analysis of lithium fluoride. For the determination of Cu, Cr, Mn, Mg, Ni, Ti, and Pb, the sample is mixed with 10% silver chloride as a buffer and cobalt as an internal standard. This mixture is loaded in a graphite electrode (U.C.P. 1991) and excited in a dc arc at 12 amperes. The spectrum is photographed on a Hilger large quartz spectrograph in which the 0 to 15" and 45 to 60" periods of the arc are superimposed to obtain one spectrum. For the determination of Na, K, and Ca, the sample is mixed with graphite as buffer and barium as an internal standard. The charge is excited in a dc arc at 10 amperes and spectrum photographed on a Kodak 1-N plate; the exposure time being 60 seconds. The lower limit of estimation is ppM for all the impurities and the precision of the method is ±15%. (auth)

46174 (BNWL–1407) CHEMICAL ANALYSES OF SODIUM SYSTEMS. Final Report. Greenhalgh, W. O.; Yunker, W. H.; Scott, F. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 56p. Dep. CFSTI.

The concept of conducting direct coulometric titrations of

oxygen ions in sodium was demonstrated using oxygen ion permeable ceramics. At least 40 successful titrations were carried out. Titration techniques and special test cells were developed specifically for coulometric application. The remaining problem areas were defined and program plans prepared for their investigation. An effort was made to develop oxygen ion polarography in liquid sodium. Characteristic polarographic curves were not obtained but much of the data developed in the coulometric investigation indicate that polarographic measurements are possible. An emission spectrographic procedure for the determination of trace metal impurities in metallic sodium was developed. The procedure is based on a lanthanum hydroxide carrier precipitation followed by direct arc emission spectrography on a solution of the precipitate. Problems normally encountered during the thermal neutron activation analysis of trace metals in sodium were largely overcome through the use of an ERBA-RAI resin to remove the activated sodium matrix. The activation analysis of trace metals in metallic sodium was demonstrated to be technically feasible. The resin separation should also prove useful when combined with atomic absorption or colorimetric procedures. Additional work is required to completely define the limits of its usefulness with these procedures. Preliminary studies were made on the direct scavenging of trace metal impurities from molten sodium using solid sorbants. The data obtained are not sufficient to indicate the technical feasibility of the approach. (J.G.B.)

46175 (CEA-N-1289) PRACTICAL CORRECTION PROGRAM FOR ELECTRON MICROANALYSIS USING COMPLEX STANDARDS. Morlevat, Jean-Pierre; Fialon, Jean-Pierre (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1970. 29p. (In French). Dep. CFSTI (U. S. Sales Only).

A computer program for electron microprobe analysis, which can be used with simple or complex standards, is described. Standards and specimens can contain up to eight elements, analyzed with various high voltages. Fluorescence, absorption, and atomic number effects are corrected respectively with Castaing and Reed's, Philibert's, and Philibert–Tixier's methods. The determination of Si in the phase $U\,Si_{1.88}$ is made with the standard U_3Si_2. The Si concentration is measured and compared to that corrected. (auth) (France)

46176 (NLCO-1061) DETERMINATION OF NITROGEN IN URANIUM METAL BY AUTOANALYSIS. Prall, J. R. (National Lead Co. of Ohio, Cincinnati). Jul 1970. Contract AT(30-1)-1156. 15p. Dep. CFSTI.

An automatic procedure was developed for the determination of nitrogen in uranium metal after dissolution of the sample in hydrochloric acid. The procedure involves the precipitation of uranium from solution by sodium hydroxide and the distillation of ammonia from the filtrate. The ammonia, which is formed when uranium nitrides dissolve in acid, is determined colorimetrically as indophenol. A Technicon AutoAnalyzer is used to perform the filtration, distillation, and colorimetric steps automatically and continuously. (auth)

46177 (NLCO-1062) DETERMINATION OF URANIUM BY AUTOANALYSIS. Prall, J. R. (National Lead Co. of Ohio, Cincinnati). Jul 1970. Contract AT(30-1)-1156. 12p. Dep. CFSTI.

A procedure was developed for the automatic, colorimetric determination of uranium using a Technicon AutoAnalyzer. The procedure employs ammonium thiocyanate as the chromogenic reagent. Uranium solutions in the range of 3 to 25 g/l may be analyzed directly. Solutions with higher uranium concentrations are analyzed after diluting them so that the uranium concentration of the diluted sample will be in the 3 to 25 g/l range. The precision of the automatic procedure was found to be comparable with the precision of the routine procedure, and no significant bias was detected. (auth)

46178 (STI/DOC-10/115) RADIOISOTOPE X-RAY FLUORESCENCE SPECTROMETRY. Report of a Panel held in Vienna, 13–17 May 1968. Technical Reports Series No. 115. (International Atomic Energy Agency, Vienna (Austria)). 1970. 112p. IAEA $3.00.

A review of radioisotope x-ray fluorescence spectrometry is presented that includes: comparison with other analytical techniques; comparison between radioisotope and conventional x-ray fluorescence analysis; comparison between primary and secondary α, β, γ and x-ray excitation; present status of the theory of radioisotope x-ray fluorescence; instrumentation and techniques (components of radioisotope x-ray fluorescence analytical instruments and systems; techniques for minimizing interference; calibration); and applications (metalliferous mineral exploration and development; on stream process control; alloy analysis; coating thickness measurement; miscellaneous applications; and health and safety considerations). (D.H.M.)

46179 (UCRL-Trans-10481) ONE-STEP CONVERSION OF ORGANIC COMPOUNDS INTO HYDROGEN FOR MASS-SPECTROMETRIC ISOTOPE ANALYSIS. Rolle, W.; Huebner, H. Translated by R. Dewar for Lawrence Radiation Lab., Livermore, Calif., from Z. Anal. Chem.; 232: 328-31(1967). 7p. Dep. CFSTI.

A method is described for the conversion of organic compounds into hydrogen for mass-spectrometric analysis of deuterium. The substances are heated in Supremax ampules with chromium powder at 685°C for 15 hr. The method is simple and was checked by reference analyses. (auth)

46180 (Y-1745) QUANTITATIVE ANALYSIS OF MICROMETER-SIZE URANIUM ALLOY POWDERS USING THE ELECTRON MICROPROBE X-RAY ANALYZER. Stewart, J. H. Jr. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 22 Sep 1970. 77p. Dep. CFSTI.

The electron probe was used in the quantitative analysis of individual microparticles of uranium–molybdenum and uranium–niobium–zirconium alloys. A computer program was applied to correct the characteristic x-ray intensities of the alloyed metals excited by the electron beam for absorption, fluorescence, and atomic number effects. The accuracy of the method is comparable to that of the conventional chemical analysis of homogeneous bulk samples. A simplified specimen preparation and handling procedure was devised to prevent the usual rapid oxidation of the polished specimen surface, which would introduce a significant nonreproducible bias into the analysis. (auth)

46181 ANALYTICAL CHEMISTRY OF ZIRCONIUM AND HAFNIUM. Mukherji, A. K. Oxford; Pergamon Press (1970). 281p. 90s.

A collection and comparison of published research results on the characterization and analysis of zirconium and hafnium is presented. The aqueous chemistry of their ions is discussed in detail. Classical and widely used methods such as gravimetry, titrimetry, and absorptiometry are presented along with spectrographic x-ray and neutron activation methods for the analysis of diverse materials. Isolation and separation of zirconium and hafnium from each other is of commercial and technological interest; the available methods are discussed and their merits and demerits presented. (auth) (UK)

46182 MASS SPECTROMETRIC ANALYSIS OF NITROGEN AND OXYGEN ISOTOPES IN NITROGEN OXIDE COMPOUNDS. Bes, R.; Lacoste, G.; Mahenc, J. (Institut du Genie Chimique, Toulouse). Method. Phys. Anal.; 6: 109-12(Jun 1970). (In French).

The gaseous decomposition of nitrogen oxides in a glow discharge permits the analysis of both nitrogen and oxygen isotopes. The voltage and frequency for obtaining a rapid decomposition of samples are given. Pressure readings are used as an indication of the chemical composition of mixtures. (auth) (France)

46183 MEASUREMENT OF ISOTOPE RATIO OF VERY SMALL AMOUNTS OF GAS BY MASS SPECTROMETRY. Donville, B.; Pagani, A. (Toulouse Univ.). Method. Phys. Anal.; 62: 113-17(Jun 1970). (In French).

A method for the precise measurement of isotope ratio by mass spectrometry when the pressure of the gas to be analyzed is very low is described. In the case of atmospheric argon, it is necessary to bring some corrections when the ^{40}Ar partial pressure is lower than 10^{-9} torr. The usual method consisting of correcting peak heights for background contribution is not completely satisfactory because a decrease of the background occurs after the first gas injection. Consequently, a new method of correction based upon a very small preliminary introduction of the gas to be analyzed is described. At very low partial pressures, the background varies with time. A method for correction at the time of the preliminary introduction is proposed. It is a graphical extension of the preceding one. The results obtained are very satisfactory since the $(^{40}Ar/^{36}Ar)$ ratio is constant (within 0.2% experimental error) from 10^{-9} to 5×10^{-10} torr. This correction method seems to be quite general since similar results were obtained with various mass spectrometers. (auth) (France)

46184 QUANTITATIVE DETERMINATION OF WATER IN TRI-n-BUTYL PHOSPHATE–NITRIC ACID–ORGANIC DILUENT AND LONG CHAIN TERTIARY AMINES–NITRIC ACID–ORGANIC DILUENT SYSTEMS BY GAS CHROMATOGRAPHY. Grossi, G.; Palombari, R. (CNEN, Rome). J. Inorg. Nucl. Chem.; 32: 2743-52(Aug 1970).

A simple, rapid, and precise method is described for the determination of water contained in organic solutions of tri-n-butyl

phosphate and long-chain aliphatic tertiary amines in the presence of nitric acid. Such systems are widely used for the recovery of uranium and plutonium from nitric acid solutions of spent nuclear fuels. (auth) (UK)

46185 URANIUM ISOTOPIC ANALYSIS AT CADARACHE LABORATORY BY THERMOIONIZATION. Gauthier, M.; Simenauer, A. (CEN de Cadarache, Saint-Paul-Les-Durance, France). Method. Phys. Anal.; 62: 175-7(Jun 1970).

The operation of a polyvalent mass spectrometer in thermoionization for the comparative measurement of uranium isotopic composition was carried on for six months without any notable breakdown at the mean rate of five samples per day. The reduction of the data was exclusively manual. The standard deviation on the relative proportion of the most abundant isotope is of the order 1‰. The three-filament assembly makes the comparison of two samples possible but introduces an intersample pollution of the order of 3%. (auth) (France)

46186 DETERMINATION OF OXYGEN, HYDROGEN, AND NITROGEN IN HIGH-MELTING METALS. IV. REASONS FOR THE SPECIAL SUITABILITY OF PLATINUM MELTS FOR OXYGEN DETERMINATION IN NIOBIUM AND TANTALUM AND DEPENDENCE OF THE ANALYSIS VALUES ON THE KIND OF SAMPLE PRETREATMENT. Lassner, E.; Kraft, G. (Metallwerk Plansee AG, Reutte/Tryol, Austria. Metallgesellschaft AG, Frankfurt am Main). J. Less-Common Metals; 22: 83-90 (Sep 1970). (In German).

It was found by means of metallographic sections that the superior performance of platinum melts in the oxygen determination in niobium and tantalum is due to the formation of a homogeneous melt without segregation of graphite lamellae or carbides. The importance of sample preparation for correct oxygen determination is stressed and preliminary acid etching is proposed as an optimum method. (auth)

46187 ATOMIC-SPECTROSCOPIC DETERMINATION OF RUTHENIUM. Rowston, W. B.; Ottaway, J. M.; Stulik, M. (Univ. of Strathclyde, Glasgow). Proc. Soc. Anal. Chem.; 7: 148-9(Aug 1970).

The results of investigations on the many interferences encounted in the atomic emission and absorption determination of Ru are reported, and the development of a satisfactory procedure for the atomic spectroscopic determination of Ru in aqueous solution, which does not require prior separation of the Ru, is described. In view of simplicity of operation, specificity, low cost, and high sensitivity, the atomic-absorption spectrophotometric technique is recommended. The flame emission and spectrographic techniques were found to be only slightly less sensitive than the atomic-absorption process but were subject to much spectral interference. (UK) (TSS)

46188 OSCILLOPOLAROGRAPHIC AND POLAROGRAPHIC INVESTIGATION OF THE ELECTRODE REACTION OF Pu AND U IONS IN CARBONATE SOLUTIONS. Casadio, S.; Orlandini, F. (CNEN-CSN, Casaccia, Italy). J. Electroanal. Chem.; 26: No. 1, 91-6(Jun 1970).

Electrode-kinetic parameters for the one-electron irreversible step of Pu(IV) reduction in 1 M Na_2CO_3 were obtained by an oscillopolarographic technique. Conventional polarographic data (half-wave potentials and diffusion coefficients) are given for the Pu(IV)/Pu(III) system in carbonate medium. Suggestions are made regarding the analytical determination of Pu valence states in mineral acid media using the carbonate ion as complexing agent. The same types of studies were carried out for the U(VI)/U(V) system. (auth)

46189 STRONTIUM ISOTOPIC COMPOSITION OF BASALTS FROM THE GORDO AND JUAN DE FUCA RISES, NORTHEASTERN PACIFIC OCEAN. Hedge, Carl E.; Peterman, Zell E. (Geological Survey, Denver). Contrib. Miner. Petrol.; 27: 114-20 (1970).

The Sr isotopic compositions were determined for twelve tholeiitic basalts dredged from the Gordo and Juan de Fuca Rises. $^{87}Sr/^{86}Sr$ ratios range from 0.7012 to 0.7031 and average 0.7026. These data, combined with other data from the East Pacific Rise, indicate that tholeiite basalts being erupted along the active rises in the Pacific Ocean contain less ^{87}Sr than basalts erupted on the islands. These isotopic differences between the ocean-ridge tholeiite and the more alkali island basalts indicate that variations in Rb/Sr have persisted in the mantle for billions of years. The possible origins and distribution of these heterogeneities are discussed. (auth)

Isotopic Procedures

Refer also to abstract 46509.

Radiometric Procedures

Refer also to abstract 46506.

46190 (BNL-50237) ON THE USE OF GAMMA-RAY SPECTROSCOPY TO DETERMINE Pu ISOTOPIC ABUNDANCES IN PLUTONIUM SOURCES. Kraner, H. W. (Brookhaven National Lab., Upton, N. Y.). May 1970. 12p. Dep. CFSTI.

It is reported that ^{240}Pu, as well as ^{238}Pu, ^{239}Pu, ^{241}Pu, and ^{242}Pu can be assayed by high-resolution γ spectroscopy. A small, calibrated, high-resolution Ge(Li) detector was used. Relative intensities of the various Pu isotopes from their γ spectra are tabulated. (J.G.B.)

46191 URANIUM DETERMINATION IN WATER WITH HELP OF SOLID-STATE-TRACK METHOD. Doerschel, E.; Stolz, W. (Technische Univ., Dresden). Radiochem. Radioanal. Lett.; 4: 277-83(31 Aug 1970). (In German).

Solid state track detectors are suitable for the detection of minute concentrations of uranium in water. In the procedure described, a known volume of liquid is placed on a track-detecting material and evaporated. The residual is covered with a second detector. Irradiated with a well-known flux of thermal neutrons, fission reactions are induced in the detector, producing charged particles. Then the detector is etched and the tracks produced are counted. The number of tracks is a direct measure of the uranium content in water. The method is suitable for water control at power stations and for the detection of uranium ore deposits. (auth)

46192 RAPID URINE ASSAY FOR TRITIUM. Wetteran, L. W.; Huebotter, R. J. (Veterans Administration Center, Los Angeles, Calif.). Health Phys.; 19: 449(Sep 1970).

Methods for the preparation of a scintillation solution and urine samples for tritium counting are described. The urine specimens were decolorized to reduce uncontrolled losses during lyophilization. The scintillation solution giving a counting efficiency of up to 40% with a variation of 1% and little quenching due to solutes present in the urine is described. (UK)

46193 RAPID DETERMINATION OF LOW-LEVEL FISSION PRODUCTS IN WATER. Eichholz, G. G.; Galli, A. N. Georgia Inst. of Tech., Atlanta). Radiochem. Radioanal. Lett.; 4: 315-23(31 Aug 1970).

A simple qualitative method for the concentration of dissolved radioactive contaminants in water is described. The method involves the slurrying of a pre-weighed amount of mixed ion-exchange resin, contained in a "tea bag," with the water sample prior to gamma counting or spectrometry. (auth)

46194 INTERLABORATORY COMPARISON OF ANALYSIS OF TRITIUM IN NATURAL WATERS. Florkowski, T.; Payne, B. R.; Sauzay, G. (International Atomic Energy Agency, Vienna). Int. J. Appl. Radiat. Isotop.; 21: 453-8(Aug 1970).

The results of determinations of tritium in natural waters made by 35 laboratories were compared. Three water samples in a concentration range of 10 to 250 T. U. were used for the intercomparison. Analyses were effected by liquid scintillation and gas counting with and without electrolytic enrichment. The results form the basis for conclusions regarding the optimal concentration range for each method of assay. (auth) (UK)

46195 BURNUP DETERMINATION OF NUCLEAR FUELS BY HIGH RESOLUTION GAMMA SPECTROMETRY, TRACK FORMATION IN SOLID-STATE DETECTORS, AND NEUTRON DOSE MEASUREMENTS. Popa, P. (Inst. of Atomic Physics, Bucharest); De Coster, M.; Langela, D. Nucl. Appl. Technol.; 9: 755-61(Nov 1970).

Results of nondestructive methods for nuclear fuel burnup determinations are presented. It is shown that in an experimental irradiation (well thermalized neutron spectrum, small fuel samples and relatively short irradiation time), the results obtained by high resolution gamma spectrometry are in agreement with those derived from the application of the solid-state track detectors technique and neutron dose measurements. The importance of the experimental errors is mainly due to the poor knowledge of the fission yields. (auth)

46196 LIQUID SCINTILLATION COUNTING OF ^{63}Ni. Harvey, B. R.; Sutton, G. A. (Fisheries Radiobiological Lab., Lowestoft, Eng.). Int. J. Appl. Radiat. Isotop.; 21: 519-23(Sep 1970).

A method for the liquid scintillation counting of ^{63}Ni is described in which the nickel is precipitated as the dipyridine nickel dithiocyanate complex and dissolved in a dioxan-based liquid scintillant for assay. Counting efficiencies well in excess of 60 per cent were obtained with a background of 20 to 25 counts per min using a Packard

Model 3320 liquid scintillation spectrometer. Quench-correction by channels ratio and external standardization is discussed. The technique was used for the determination of small amounts of ^{63}Ni present in liquid radioactive wastes from nuclear power stations. (auth) (UK)

46197 IMPROVED METHOD FOR THE DETERMINATION OF ^{32}P IN PLANT MATERIAL. Nagaraj, G.; Sriramamurty, C.; Gopalachari, N. C. (Central Tobacco Research Inst., Rajahmundry, India). Int. J. Appl. Radiat. Isotop.; 21: 563-4(Sep 1970).

A modification to the method of Mackenzie and Dean (Anal. Chem., 20: 559(1948)) is described, with a view to improving the efficiency of the procedure. This modified method was applied to radioactive tobacco leaf samples from a radiotracer experiment. The ^{32}P count rates obtained by the modified procedure were about 8% higher than by the original method; this may have been due to a decrease in self-absorption effects. Another possible explanation for the difference in the count rates between the two methods may be the non-quantitative collection of the magnesium ammonium phosphate precipitate in the original method. The modified method does not require a special filtration set-up, and in addition to being more efficient it is quicker. (UK)

Activation Procedures

Refer also to abstracts 46497 and 46505.

46198 (NBS-TN-508) ACTIVATION ANALYSIS. Summary of Activities, July 1968 to June 1969. LaFleur, Philip D. (ed.) (National Bureau of Standards, Washington, D. C.). Jul 1970. 147p. GPO $1.25.

The design and installation of irradiation facilities for the NBS Reactor are described, and studies on the operating characteristics of the pneumatic tube facilities have begun. Procedures have been developed for determining molybdenum in the presence of large amounts of tungsten and for the determination of uranium. Methods for determining a contamination free blank for application to liquid samples, a study of the application of neutron activation to the analysis of stained glass were also begun. The application of thermal and fast neutron activation analysis and photonuclear activation analysis to the NBS Standard Reference Material program is discussed. Applications of 3-MeV neutrons from a Cockcroft–Walton neutron generator to activation analysis and of the 3-MeV neutron buildup in 14-MeV neutron activation have been studied. The determination of carbon by photonuclear activation has been extended to various metals other than sodium; thallium has been determined in glass samples by photon bombardment; and the photofission of thallium, bismuth, and lead has been studied. Hydrated antimony pentoxide has been used to separate sodium from glass samples for subsequent instrumental activation analysis, and the antibiotic, tetracycline, has been applied to radiochemical separations. (auth)

46199 (Y-1733) DETERMINATION OF BERYLLIUM BY GAMMA ACTIVATION. Kienberger, C. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). 14 Sep 1970. Contract W-7405-eng-26. 19p. Dep. CFSTI.

A short, precise, and economical method was developed for determining the amount of beryllium in samples of beryllium metal, beryllium compounds, and beryllium oxide. The beryllium samples are prepared by dissolving them in a hydrofluoric acid solution or by compressing the powder in a stainless steel dish. The prepared samples are gamma activated with an antimony-124 source. The beryllium is determined by counting the neutrons produced and comparing the counting rate to that of a beryllium standard. The precision of a single analysis, at the 95 percent confidence level, is ±0.2 percent of the value. There is no significant bias in the analysis. An analysis can be made in about one-half hour. (auth)

46200 ROUTINE DETERMINATION OF VANADIUM IN SILICATE ROCKS BY NEUTRON ACTIVATION ANALYSIS. Das, H. A.; de Graaff, N.; Hoede, D.; Zonderhuis, J. (Reactor Centrum Nederland, Petten, Netherlands). Radiochem. Radioanal. Lett.; 4: 307-14(31 Aug 1970).

A routine method is presented for the determination of vanadium in silicates by neutron activation. The samples are dissolved prior to irradiation. The 3.8-min ^{52}V activity is isolated by solvent extraction with N-benzoylphenylhydroxylamine. (auth)

46201 CONTRIBUTION TO THE PROBLEM OF OXYGEN CONTENT DETERMINATION BY 14-MeV NEUTRON ACTIVATION. Adamek, A.; Severa, F. (Inst. of Physics, Bratislava). Radiochem. Radioanal. Lett.; 4: 301-6(31 Aug 1970).

An activity distribution both in radial and axial directions in the samples analyzed for oxygen was investigated in connection with the systematic errors in 14-MeV neutron activation analysis. Minimizing these errors, the best geometric shapes of samples are determined under given conditions. (auth)

46202 FURTHER ANALYSES OF UNIVERSITY OF KENTUCKY REFERENCE AND ALKALOID SERIES CIGARETTES BY INSTRUMENTAL NEUTRON ACTIVATION ANALYSIS. Nadkarni, R. A.; Ehmann, W. D. (Univ. of Kentucky, Lexington). Radiochem. Radioanal. Lett.; 4: 325-35(31 Aug 1970).

The determination of fourteen trace elements has been carried out on analytical samples of the University of Kentucky reference and Alkaloid series cigarette tobaccos. The elements La, As, Br, Hg, Cr, Se, Ag, Cs, Eu, Zn, Fe, Co, Sc, and Sb were determined by instrumental neutron activation. No correlation between amounts of nicotine and the trace element levels in the cigarettes was found. It was found that pooled tobacco samples from a rather large randomly selected population of cigarettes were required to obtain trace element data of value for interlaboratory comparison. The smoke condensates prepared from the 1R1 reference cigarettes were also analyzed for these elements and the percentage transference values were calculated. (auth)

46203 DETERMINATION OF OXYGEN IN STEEL BY NEUTRON ACTIVATION USING THE ANALOX. Armson, F. J.; Bennett, H. L. (Guest Keen Nettlefolds, Wolverhampton, Eng.). J. Iron Steel Inst. (London); 208: 748-51(Aug 1970).

The "Analox" neutron activation instrument for the determination of oxygen in steel has been in use at Brymbo Steelworks for about four years and early favorable impressions of the equipment have been confirmed. It has been found that the expected output of at least 100 samples per shift can be easily achieved. In the range 0.01 to 0.05% oxygen, means of duplicate results for samples analysed on different days usually agree to within 0.002%, and at the 0.01% oxygen level, the standard deviation is 0.001%. Below 0.005%, some discrepancies have been noted in comparison with other techniques, but the evidence indicates that the Analox is as reliable as any other procedure for low-oxygen contents in the range 0.002 to 0.005%. (auth) (UK)

46204 QUANTITATIVE INVESTIGATIONS ANALYSIS OF SILVER BY NEUTRON ACTIVATION IN A CASE OF GENERALIZED ARGYROSIS. Czitober, H. (Univ., Vienna); Frischauf, H.; Leodolter, I. Virchows Arch A; 350: 44-51(1970). (In German).

In a case of excessive generalized argyrosis the silver content of skin, liver, and bone biopsies has been determined by neutron activation. There was an eighty fold increase in silver content of the skin as compared to normal controls. The values for liver and bone samples were only three to four fold above those of the controls. Quantitatively the silver content of the skin and liver was about the same. (auth)

46205 NEW TECHNIQUE FOR 14-MeV NEUTRON ACTIVATION ANALYSIS IN FLOWING SYSTEMS. Bibby, D. M.; Oldham, G. (Loughborough Univ. of Tech., Eng.). Int. J. Appl. Radiat. Isotop.; 21: 491-6(Aug 1970).

An economic method of fast neutron activation analysis using a neutron generator was devised for use in flowing systems whereby short period irradiations are used followed by determination of the total count of active liquid. Selection of the critical flow rate for the particular isotope to be determined reduces interference from other elements present. (auth) (UK)

46206 SUBSTOICHIOMETRIC SEPARATION AND DETERMINATION OF TANTALUM BY NEUTRON ACTIVATION METHOD. Zmijewska, Wanda (Inst. of Nuclear Research, Warsaw). Chem. Anal. (Warsaw); 15: 471-8(1970).

A method of substoichiometric separation of tantalum has been developed. The method consists of the extraction of the tantalum complex with methyl violet by benzene from 0.2 M HF medium. The method has been applied to the determination of tantalum in silicon of semiconductor purity in combination with the neutron activation analysis. The standard deviation of the determination of 0.010 μg Ta amounted to 13.9 and 9.1% when measured by means of a scintillation counter and γ spectrometer, respectively. (auth)

46207 USE OF ELECTRON ACCELERATORS FOR NONDESTRUCTIVE ASSAY OF NUCLEAR MATERIALS. Bramblett, Richard L. (Gulf General Atomic Inc., San Diego, Calif.). Int. J. Nondestruct. Test.; 2: 99-127(Sep 1970).

A research and development program is being carried out at Gulf General Atomic to develop quantitative measurement techniques for special nuclear material which is difficult to measure by conventional means. The approach taken is to irradiate the item to be measured with a penetrating radiation beam from a

LINAC. The beam produces characteristic nuclear reactions such as the photofission and photoneutron reactions and the resulting reaction radiations are measured with detector systems. The reaction radiations include prompt neutrons, delayed neutrons, and gamma rays from fission products. From the intensities of the reaction radiations, the isotropic content and the quantity of nuclear materials may be determined. The reaction yields from a number of nuclear materials have been measured. These include the bremsstrahlung induced photoneutron yield from 5 to 10 MeV in ^{235}U, ^{238}U and ^{239}Pu. The photofission produced time distribution of delayed neutrons and the spectra of post-beta decay gamma rays have also been measured for the same isotopes. Quantitative isotopic assays on metal, oxide, and water containing samples with precisions near 1% have demonstrated the validity of the technique. A small, transportable electron accelerator has been designed and is under construction at Gulf General Atomic. A roadable trailer is being modified to contain the accelerator, a barrel scanner, and detection and data accumulation electronics. The trailer will be used at various sites throughout the country to demonstrate nondestructive assay techniques. Such demonstrations are expected to stimulate the application of nondestructive assay techniques throughout the nuclear fuel industry. (auth)

46208 ANALYSIS OF STABLE IODINATED INSULIN BY NEUTRON-ACTIVATION TECHNIQUES. Cardarelli, John A.; Podolsky, Stephen; Burrows, Belton A. (Veterans Administration Hospital, Boston. Boston Univ.). Int. J. Appl. Radiat. Isotop.; 21: 513-17(Sep 1970).

Neutron activation analysis of stable iodinated insulin was performed using the $^{127}I(n,\gamma)^{128}I$ reaction. Using a lithium-drifted germanium detector for counting the ^{128}I gamma ray of 0.442 MeV, less than one microgram of iodine was determined without the necessity of pre- or post-irradiation chemistry. The theoretical lower limit for ^{128}I using this technique appears to be 40 to 50 ng of iodine. Increased sensitivity was achieved by using a NaI(Tl) well detector with post-irradiation chemistry. The results indicated that with this destructive method as low as 1 to 2 ng of iodine could be measured. Excellent recovery of insulin by immunoassay, after neutron activation, provided evidence that the technique using freeze drying of the insulin and a Ge(Li) detector did not damage the insulin molecule. It is concluded that, using two different detector systems after neutron activation, accurate and reliable studies could be performed with iodinated insulin and other proteins in biological function studies. (auth) (UK)

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Refer also to abstracts 46188, 46276, 46277, 46307, 46317, 46323, 46324, 46327, 46763, 46787, 46792, 47004, 47329, 47334, 47574, and 47932.

46209 (LIB/Trans-261) THE CHELATE FORMATION OF PENTAVALENT NEPTUNIUM AND PLUTONIUM WITH α-AMINO ACIDS. Wede, Ulrich (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Radiochemie). Translated by W. Buykx (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report KFK-837. 37p. Dep. CFSTI (U. S. Sales Only).

Photometric titration and cation exchange methods were used to study the formation of Pu(V) and Np(V) chelates with α-amino acids. Glycine formed a 1:1 and 1:2 chelate. Dibasic and tribasic α-amino acids formed hydrogen complexes and 1:1 chelates. At pH 10 the chelates of the polybasic ligands were hydrolysed to chelate hydroxides. On the basis of composition and the various values obtained for stability constants, three types of compound were deduced. These were: eight-membered monocyclic hydrogen complexes, bicyclic hydrogen chelates or normal chelates consisting of 2 five-membered rings, and chelate hydroxides. (Australia)

46210 (NLCO-1068) PRODUCTION OF URANIUM TETRAFLUORIDE AND URANIUM METAL. Mautz, E. W. (National Lead Co. of Ohio, Cincinnati). 23 Apr 1970. Contract AT(30-1)-1156. 21p. (CONF-700534-2). Dep. CFSTI.

From American Institute of Mechanical Engineering Uranium Symposium, Socorro, New Mexico.

The main sources of feed materials are given for the production of uranium tetrafluoride and uranium metal at the National Lead Company of Ohio. The historical background of uranium tetrafluoride and uranium metal production facilities is presented together with the primary manufacturing techniques currently in use. (auth)

46211 (UR-49-1327) NUCLEAR MAGNETIC RESONANCE STUDIES OF THE CHELATION OF URANYL IONS BY ADENINE NUCLEOTIDES. Rich, Kenneth E. (Rochester Univ., N. Y.). 1970. 162p. Dep. CFSTI.

Thesis.

The structures of the various complexes present in neutral and alkaline mixtures of uranyl nitrate with the three adenine 5′-nucleotides — AMP, ADP, and ATP were studied by nuclear magnetic resonance. Nuclear magnetic resonance spectra, both proton (100 MHz) and phosphorus (40.5 MHz), were obtained for uranyl nitrate–adenosine 5′-monophosphate (U–AMP), –adenosine 5′-diphosphate (U–ADP), and –adenosine 5′-triphosphate (U–ATP) mixtures in D_2O having various stoichiometries and basicities over the pD range ~7 to 11. The spectra of U–AMP indicate that in equimolar mixture (0.1 M and 0.05 M) the strong chelate with 1:1 stoichiometry (whose structure was previously given as a 2:2 sandwich-type (ST) dimer), which is exclusively present above pD 10.9, disproportionates below this pD to uncomplexed AMP, sandwich-type chelates (two forms) with 2:1 (U–AMP) stoichiometry, and nonsandwich-type (non ST) complex(es). Only the latter type of complex is present at pD 7.5 in 0.05 M equimolar mixture. The extent of disproportionation and the ligand exchange rate both increase with decreasing pH, probably due mainly to the competition between uranyl ions and protons for the ribose hydroxyl-oxygen sites. Structures for the 2:1 chelates, and also 3:1 chelates, compatible with the spectra, are suggested. A series of equilibria are suggested to describe the U–AMP system from pH 2 to 11.5. The spectra also indicate that from pD 7.7 to 11 an equimolar U–ATP mixture consists of 2:2 ST dimeric chelates in which the ligands are the β and γ phosphoryl groups and the ribose hydroxyls, but from pD 6.8 to 7.3 non ST chelates in which the uranium is bound only to the β and γ phosphoryl groups predominate. About 10% of the complex is in the ST form at pD 7.3 in 1:1 0.05 M U–ATP solution, but none is present in a 1:2 solution at the same pD and uranium concentration. Unlike the U–ATP and U–AMP systems, the U–ADP system does not contain 2:2 ST complexes at any pD. Rather, at pD 7.7 only non ST complexes, in which uranium is chelated by the two phosphoryl groups, exist in 1:1 and 1:2 U–ADP mixtures, but these disproportionate to 4:2 ST chelates and free ADP above pD 7.7. Unlike the behavior of non ST U–AMP complexes, U–ADP non ST complexes (adenine) ring-stack to a greater extent than do free ADP ions. The U–ATP complex (non ST form) dephosphorylates completely to the non ST U–ADP complex in near-neutral solution within two days at 27°C, but at higher pD, 9.7, dephosphorylation of U–ATP (ST form) directly to the U–AMP ST complex seems to occur. The relative stabilities of the 2:2 uranyl ion–adenine nucleotide sandwich-type chelates were shown to be U–ATP ≫ U–AMP ≫ U–ADP with respect to dissociation and/or disproportionation. The elucidation of the structures of the various complexes present in uranyl ion–adenine nucleotide solution made possible the postulation of a mechanism for the nonenzymatic catalysis of ATP hydrolysis by strongly-hydrolyzable metal ions and a mechanism for enzymatic metal ion catalysis of ATP hydrolysis. (auth)

46212 GRAFT POLYMERIZATION OF STARCH IN NOVEL ALCOHOL REACTION MEDIUM. Reyes, Zoila; Russell, Charles R. (to Secretary of Agriculture). U. S. Patent 3,518,176. 30 Jun 1970. Filed 25 Feb 1966.

A process for graft polymerization of a vinyl monomer in an aqueous medium onto a starch, amylose, or amylopectin comprises replacing the water with an equal volume of ethylene glycol, glycerol, butanol, sorbitol, or dimethylformamide. The reaction is catalyzed by radiation or ceric ions. (Offic. Gaz.)

46213 DIRECT PROTON MAGNETIC RESONANCE CATION HYDRATION NUMBER MEASUREMENTS OF $SnCl_4$, $SnBr_4$, $UO_2(ClO_4)_2$ AND $Zn(ClO_4)_2$, IN WATER-ACETONE MIXTURES. Fratiello, A.; Kubo, V.; Lee, R. E.; Peak, S.; Schuster, R. E. (California State Coll., Los Angeles). J. Inorg. Nucl. Chem.; 32: 3114-6(Sep 1970).

It is stated that it has been demonstrated that the PMR technique provides a quantitative means of measuring cation hydration numbers, and estimating the extent of complex formation and competitive solvation in aqueous electrolyte solutions. At temperatures in the range −50 to −100°C the proton exchange rate can be reduced sufficiently to permit the observation of separate PMR signals for water molecules in the cation solvation shell and in bulk medium. Determination of the hydration numbers for diamagnetic UO_2^{2+}, Sn^{4+}, and Zn^{2+} is described using this technique, and preliminary results are given for solutions of paramagnetic Er^{3+}, Fe^{2+}, Fe^{3+}, and Ni^{2+}. Hydration numbers of 4, 2, and 6 were obtained for the former ions, respectively, for solutions in water–acetone mixtures. The UO_2^{2+} hydration number in ClO_4^- solutions was unchanged over a wide range of acetone concentration, reflecting the fact that coupled formation was not occurring with

this anion. The central U^{6+} ion showed a maximum coordination number 6 in this medium, since it was bonded to the two oxygen atoms in the cation and to four water molecules of hydration. (UK)

46214 KINETIC PARAMETERS OF THE DEUTERIUM + OXYGEN REACTION. Baldwin, R. R.; Rossiter, B. N.; Walker, R. W. (Univ. of Hull, Eng.). Trans. Faraday Soc.; 66: 2004-15(Aug 1970).

Studies have been made at 500°C of the second limit, and of the induction period and maximum rate of the slow reaction, of D_2 + O_2 + N_2 mixtures in aged boric-acid-coated vessels. The results enable the velocity constant ratios $k_{11D}/k_{10D}^{\frac{1}{2}}$, $k_{9D}/k_{2D}k_{10D}^{\frac{1}{2}}$, k_{14D}/k_{2D} and k_{15D}/k_{1D}, to be evaluated. From a comparison of the rates and peroxide concentrations in the hydrogen and deuterium systems, a value of k_{7D} can be obtained. (auth) (UK)

46215 FORCE CONSTANTS AND GENERALISED MEAN SQUARE AMPLITUDES OF ETHYLENE OXIDE, ETHYLENE OXIDE-d_4 AND ETHYLENE SULPHIDE. Venkateswarlu, K.; Joseph, P. A. (Kerala Univ. Centre, Cochin, India). J. Mol. Struct.; 6: 145-51(Aug 1970).

The generalised mean square amplitudes of vibration for both bonded and nonbonded atom pairs were evaluated for the molecules C_2H_4O, C_2D_4O, and C_2H_4S. While the parallel mean square amplitudes of characteristic bonds remained more or less unaltered by the substitution, the perpendicular mean square amplitudes and the mean cross-products were affected considerably by the mass effect and change in environment. (auth)

46216 IR SPECTRUM OF THE NITROSODICYANMETHANIDE ION $[ONC(CN)_2]^-$. Kolbe, Alfred; Koehler, Helmut (Martin-Luther-Univ., Halle-Wittenberg, Ger.). Z. Anorg. Allg. Chem.; 373: 230-6(Apr 1970). (In German).

The infrared spectrum of $[ONC(CN)_2]^-$ is described and an assignment is given. In order to facilitate this assignment, ^{15}N was used. Complexes, formed by this anion, were also investigated by means of ir spectroscopy. The shift of the bands of the anion are reported and a discussion concerning the bonding relations of the complexes is given. Some remarkable isotopic effects are mentioned. (auth)

46217 DIFFUSION OF ^{233}U IN THE EUTECTIC LiCl-KCl MELT. Geldner, E.; Knacke, O.; Mueller, F. (Technische Hochschule, Aachen. Kernforschungsanlage, Juelich, Ger.). Z. Anorg. Allg. Chem.; 372: 14-20(Jan 1970). (In German).

The diffusion coefficients D of UCl_4 and $UOCl_2$ in the eutectic LiCl–KCl melt at 370 to 610°C have been determined, using α-active ^{233}U as a tracer, to be: $UCl_4/D = 1.13 \cdot 10^{-3}\ e^{-4300/RT}$; $UO_2Cl/D = 1.76 \cdot 10^{-3}\ e^{-7500/RT} cm^2/sec$. (auth)

46218 ELECTRIC CONDUCTIVITIES, DENSITIES, AND SURFACE TENSIONS OF MOLTEN SALTS IN THE SYSTEM LiCl-UCl_4. Bogacz, Aleksander; Ziolek, Bozena (Polytechnical Univ., Wroclaw). Rocz. Chem.; 44: 857-70(1970).

The isotherms of specific and equivalent conductivities, average activation energies of equivalent conductivities, molar volumes, and surface tensions experimentally determined in the molten mixtures of the system LiCl–UCl_4 were compared to the solid-liquid phase diagram in the same system. (auth)

46219 HYDROGEN ISOTOPE EXCHANGE CATALYSED BY TANTALUM MONOCARBIDE. Clark, A. J.; Gasser, R. P. H.; Whitehead, P. Trans. Faraday Soc.; 66: 2085-7(Aug 1970).

A tantalum monocarbide filament heated above 600°K acts as a catalyst for the equilibration of a mixture of hydrogen and deuterium. The efficiency of exchange rose to about 3% at a filament temperature of 1000°K and was then constant up to 1400°K. The shape of the equilibration curve suggests that the reaction took place by the Bonhoeffer-Farkas mechanism. (auth) (UK)

46220 STANDARD FREE ENERGY OF NITRIDE FORMATION FROM THE ELEMENTS, AN ESTIMATION TECHNIQUE. Anderson, R. N.; Parlee, N. A. D. (Stanford Univ., Calif.). High Temp. Sci.; 2: 289-92(Sep 1970).

A correlation of standard free energies of formation at 298°K of oxides with nitrides has been used to predict unknown ΔG_f^0 values for nitrides when only information for the oxide of the element is available. A method of extrapolating the standard free energy of formation at 298°K to higher temperatures also is described. (auth)

46221 ENTHALPY OF URANIUM DIBORIDE FROM 1300 TO 2300°K BY DROP CALORIMETRY. Fredrickson, D. R.; Barnes, R. D.; Chasanov, M. G. (Argonne National Lab., Ill.). High Temp. Sci.; 2: 299-301(Sep 1970).

A drop calorimetric system has been used to measure the enthalpy of uranium diboride in the temperature range 1300 to 2300°K, relative to 298.15°K. The data obtained can be represented by the equation $(H_T^0 - H_{298.15}^0) = 1.95426 \times 10^{-2}T - 7.92334 \times 10^{-6}T^2 + 6.31409 \times 10^{-9}T^{-1} + 1.37976 \times 10^{-9}T^3 - 179{,}666.43$ cal/mole, where T is temperature in degrees Kelvin. Values of C_p^0, $H_T^0 - H_{298.15}^0$, S^0, and $(G_T - H_{298}^0)/T$ are tabulated. This work both complements and extends the earlier data as reported in High Temp. Sci., 1: 373(1969), which covered the temperature range 600 to 1500°K. (auth)

46222 DISSOLUTION OF U_3O_8 WITH SO_2. II. THE INFLUENCE OF THE TEMPERATURE ON ITALIAN MINERAL DISSOLUTION. Saracco, Giovanni Battista; Piccinini, Norberto (Politecnico, Turin). Ann. Chim. (Rome); 60: 335-42(1970). (In Italian).

Data are reported relating to a study on the dissolution of U_3O_8 in aqueous suspension by means of SO_2 and air, with or without $Fe_2(SO_4)_3$ as oxidizing agent. Investigation of the influence of temperature on the dissolution kinetics showed that a rapid increase in dissolution rate took place between 20 and 30°C, slowing down between 30 and 55°C. It was also found that the optimum air/SO_2 ratio values (α) found for T = 20°C remained unchanged when higher temperatures were studied. The behavior of an Italian uraniferous mineral was found to be similar to that of pure U_3O_8. When expressed as percent/hour, the dissolution rate values were of the same order as those obtained with U_3O_8 only. (auth)

46223 METAL ISOTOPE EFFECT ON THE RAMAN SPECTRUM OF SOLID $[Zn(NH_3)_4]I_2$. Takemoto, James; Nakamoto, Kazuo (Marquette Univ., Milwaukee). J. Chem. Soc., D; No. 16, 1017(Aug 1970).

The A_1 and F_2 Zn–N stretching vibrations of the Raman spectrum of solid $[Zn(NH_3)_4]I_2$ have been assigned by using the metal isotope technique: the A_1 mode shows almost no dependence on the isotopic substitution of the central metal atom, whereas the F_2 mode is metal isotope-sensitive. (auth) (UK)

46224 2,6-LUTIDINE N-OXIDE ADDUCTS WITH SOME HEAVY METAL TETRACHLORIDES. Karayannis, N. M.; Speca, A. N.; Pytlewski, L. L.; Labes, M. M. (Drexel Univ., Philadelphia). J. Less-Common Metals; 22: 117-21(Sep 1970).

The interaction of heavy metal tetrachlorides with excess 2,6-lutidine N-oxide (LNO) in acetone led to the precipitation of $MCl_4 \cdot 3LNO$ (M = Zr,Pt) and $MCl_4 \cdot 2LNO$ (M = Hf, Te, Th) adducts. These compounds have been characterized by means of infrared spectral studies and formulated as follows: $[MCl_4(LNO)_3]$ (M = Hf, Te, Th), cis-octahedral; $[ZrCl_4(LNO)_3]$, monomeric, involving a low symmetry heptacoordinated structure; $[PtCl_3(LNO)_3]^+$, a cis-octahedral cationic complex. The shifts of ν_{N-O}, and the ring C–H out-of-plane deformation mode, were interpreted in terms of the absence of metal-ligand π-bonding in the Zr(IV), Hf(IV), Te(IV), and Th(IV) adducts. π-bonding probably occurs in the Pt(IV) complex, but to a lesser extent than that reported for 3d metal halide complexes with pyridine N-oxides. Splittings of ν_{N-O}, ν_{M-O} and ν_{M-Cl} were indicative of a cis-arrangement of LNO groups in the adducts. (auth)

46225 DECARBOXYLATION OF METAL TRICHLOROACETATES. Moehlmann, G.; Starke, K. (Univ., Marburg, Ger. Univ. of Kentucky, Lexington). Z. Anorg. Allg. Chem.; 374: 77-85(Apr 1970).

The decarboxylation of trichloroacetate ion in basic solvents produces the intermediate trichlorocarbanion which may split into chloride and dichlorocarbene or combine with a proton to chloroform. Conditions under which protonation predominates were examined for possible use of the reaction for synthesizing metal compounds in nonaqueous solvents. The metal trichloroacetates studied included Ca, Sr, Cu, and uranyl. (auth)

46226 REACTIONS OF URANIUM CARBONITRIDES AND URANIUM NITRIDE WITH AQUEOUS SOLUTIONS OF HYDROCHLORIC, SULFURIC, AND NITRIC ACIDS. Sears, Mildred Bradley (Oak Ridge National Lab., Tenn.). J. Inorg. Nucl. Chem.; 32: 2971-84(Sep 1970).

Uranium carbonitrides reacted with 6 M HCl or 6 M H_2SO_4 to yield primarily CH_4, H_2, NH_4^+, and either U^{4+} or a $U(SO_4)_2 \cdot 4H_2O$ precipitate. At 80°C, $UN_{0.77}C_{0.23}$ was inert in water, but $UC_{0.69}N_{0.25}$ hydrolyzed to CH_4, H_2, NH_4^+, and UO_2. Uranium mononitride reacted with 0.5 to 15.8 M HNO_3 producing a yellow uranyl nitrate solution, N_2, nitrogen oxides, HNO_2, and, under some conditions, NH_4^+. The uranium carbonitrides reacted exothermally with nitric acid, yielding the same products that were obtained with uranium mononitride, as well as CO_2, unidentified nitric acid-soluble organic compound(s), and in some cases, black organic residues. Ammonium

ion was an intermediate in the oxidation of nitride or carbonitride nitrogen to N_2. (auth) (UK)

46227 RAZVITIE OBSHCHEI NEORGANICHESKOI I ANALITICHESKOI KHIMII V SSSR. (Development of General, Inorganic, and Analytical Chemistry in the USSR). Zhavoronkov, N. M. (ed.). Sovetskaya Nauka i Tekhnika za 50 Let, 1917–1967. Moscow; Izdatel'stvo Nauka (1967). 324p.

A general review is given on inorganic and analytical chemistry data collected during the last 50 years. The first part of the book covers the chemistry of natural salts, which includes: chemistry of metals and alloys; chemistry of complex compounds, rare earths, and silicates; radiochemistry; chemistry of semiconductors; quantum inorganic chemistry; and crystallography of inorganic compounds. Analysis of inorganic substances is covered in the second part. (396 references.) (R.V.J.)

46228 ISOTOPE EFFECT AND TEMPERATURE EFFECT IN THE ^2H NMR SPECTRA OF PARTLY DEUTERATED HYDRATES: THEORETICAL TREATMENT. Rossi, M.; Pasimeni, L. (Univ., Padua). Chem. Phys. Lett.; 6: 468-72(1 Sep 1970).

Recent experimental work has shown that isotope substitution and variation of temperature produce a shift in the quadrupole coupling constant of opposite sign to that which could be predicted on the basis of a previous theory (Bayer theory). The problem was solved by investigating, one by one, all the possible sources of vibrational effects: both the internal field and the interaction with the neighbouring molecules were studied as functions of intramolecular and intermolecular vibrations. It was found that the experimental effect can be explained by considering the change in conjugation of the atomic orbitals involved in the hydrogen bond with torsional coordinates. (auth)

46229 FORMATION OF DICYCLOPENTADIENYL BERKELIUM CHLORIDE. Laubereau, P. G. (Oak Ridge National Lab., Tenn.). Inorg. Nucl. Chem. Lett.; 6: 611-16(Jul 1970).

In reactions of $BkCl_3$ with a melt of $Be(C_5H_5)_2$, under microsynthesis conditions, both the tricyclopentadienyl complex, $Bk(C_5H_5)_3$, and the dicylopentadienyl chloride, $[Bk(C_5H_5)_2Cl]_2$, were formed. Although the latter type compound was known to exist with the lanthanide elements, this is thought to be the first preparation of an actinide homologue. The method of synthesis is described, and the compound was identified by x-ray powder photography as being of the same nature as the known Sm compound. The chloride was stable under vacuum, and its sublimation behavior was similar to that of the Sm compound; both compounds showed a marked tendency to form clusters of fine needles when sublimed. Attempts to obtain a single crystal by sublimation were unsuccessful. The absorption spectrum of the crystals was similar to that of $Bk(C_5H_5)_3$, the most significant difference being a band which appeared to be shifted from 730nm to 713nm. Data on the most intense absorptions in the region 400 to 990nm are tabulated. (UK)

46230 MEAN AMPLITUDES OF VIBRATION AND RELATED QUANTITIES FOR LIGHT AND HEAVY PROPANE. Cyvin, S. J.; Vizi, B. (Technical Univ. of Norway, Trondheim. Univ. for Chemical Industries, Veszprem, Norway). Acta Chim. Acad. Sci. Hung.; 64: 357-63(1970).

A harmonic force field was developed for propane molecules, based on uncorrected observed frequencies from literature. The force constants were used to calculate some spectroscopic quantities for C_3H_8 and C_3D_8 of interest in refined structure studies: mean amplitudes of vibration; perpendicular amplitude correction coefficients; and atomic vibration mean-square amplitudes. (auth)

46231 COMPARISON OF H_4 AND H_6 AS TRANSITION STATES FOR THE HYDROGEN–DEUTERIUM EXCHANGE REACTIONS. Wright, James S. (Laboratoire de Chimie Theorique, Orsay, France). Chem. Phys. Lett.; 6: 476-8 (1 Sep 1970).

A possible reaction path for the hydrogen–deuterium exchange reaction is discussed, based on the low energy calculated for H_6. (auth)

46232 TEMPERATURE DEPENDENCE OF GASES RELEASED FROM UO_2 PELLETS WITH POLYVINYL ALCOHOL BINDER. Hoshino, Akira; Matsuda, Yuji; Iso, Shuichi; Ouchi, Misao (Japan Atomic Energy Research Inst., Tokyo). Nippon Genshiryoku Gakkaishi; 12: 442-8(1970). (In Japanese).

Samples were prepared by subjecting UO_2 pellets containing 1% poly(vinyl alcohol) binder to thermal treatment under vacuum at temperatures of 150, 300, 500, 800, 1000, 1300, and 1500°C. Each pellet was then heated, and the composition of the released gas was examined mass spectrophotometrically, and the results were related to the extraction temperature (400, 1000, and 1700°C). The major components of the gas were found to be H_2 and CO, with minor contents of CO_2, N_2, and some hydrocarbons. Higher temperature of extraction raised the H_2 content and the ratio of CO to CO_2, and lowered the CO_2 content. For reference information, an experiment was also carried out on the thermal decomposition behavior of poly(vinyl alcohol). (auth)

46233 URANIUM–OXYGEN LATTICE VIBRATIONS OF ALKALI MONOURANATES. Ohwada, K. (Japan Atomic Energy Research Inst., Ibaraki). Spectrochim. Acta, Part A; 26: 1723-30(Aug 1970).

Normal coordinate treatment of the optically active U–O lattice vibrations of K_2UO_4, Cs_2UO_4, and Rb_2UO_4 was made on the basis of a simple layer model of infinite $[(UO_2)O_2]^{2-}$. Based on the results of this treatment, some of the observed bands were assigned to the U–O lattice vibrations. The force constants of U–O bonds were obtained. (auth) (UK)

46234 KINETICS OF HYDROGEN–DEUTERIUM EXCHANGE IN POLY(N-VINYLACETAMIDE) MEASURED BY INFRARED SPECTROSCOPY. Hvidt, Aase; Corett, Ruth (Univ. of Copenhagen). J. Amer. Chem. Soc.; 92: 5546-50(23 Sep 1970).

The hydrogen–deuterium exchange in D_2O solutions of poly(N-vinylacetamide) was studied as a function of pD at four temperatures. The rate constants observed for the exchange of the hydrogen atoms of the amide groups of the polymer are lower by a factor of ~20 than the corresponding exchange rate constants of N-methylacetamide. The interpretation of this observation is discussed and, as a likely explanation of the result, it is suggested that fast fluctuations of the conformation of the dissolved polymer molecules occur, and that the amide groups of the polymer are protected from solvent exposure for about 95% of the time. (auth)

46235 MECHANISTIC PHOTOCHEMISTRY OF γ-HYDROXY-γ-PHENYLBUTYROPHENONE. THE NATURE OF THE 1,4-BIRADICAL INTERMEDIATE. Lewis, Frederick D. (Northwestern Univ., Evanston, Ill.). J. Amer. Chem. Soc.; 92: 5602-8(23 Sep 1970).

The mechanistic photochemistry of γ-hydroxy-γ-phenylbutyrophenone (1) and its β,γ-dideuterio derivative (2) was investigated. The presence of a biradical intermediate formed by γ-deuterium abstraction upon photolysis of (2) was established by the formation of deuterium–hydrogen exchanged ketone. A deuterium isotope effect on the rate constant for γ-hydrogen abstraction of 1.7 is observed. A kinetic analysis shows that bond rotations in the biradical are about five times slower than reabstraction of hydrogen or elimination to give acetophenone. (auth)

46236 MECHANISM OF FORMATION 1,2,3,4-TETRAMETHYLNAPHTHALENE FROM 2-BUTYNE AND TRIPHENYLTRIS(TETRAHYDROFURAN)CHROMIUM(III). Whitesides, George M.; Ehmann, William J. (Massachusetts Inst. of Tech., Cambridge). J. Amer. Chem. Soc.; 92: 5625-40(23 Sep 1970).

Reaction of triphenyltris(tetrahydrofuran)chromium(III) (1) with 2-butyne yields, inter alia, 1,2,3,4-tetramethylnaphthalene (2). A free or metal-complexed tetramethylcyclobutadiene was excluded as an intermediate in this reaction by the observation that 1,2-dimethyl-3,4-di(methyl-d_3)naphthalene (4) is not a product of 1 and 2-butyne-1,1,1-d_3 (3). Examination of the relative yields of 1,2,3,4,5-pentamethylnaphthalene (5) and 1,2,3,4,6-pentamethylnaphthalene (6) formed in reaction of 2-butyne with tri-o-tolyl-, tri-m-tolyl-, and tri-p-tolyltris-(tetrahydrofuran)chromium(III) demonstrates that a long-lived aryne–chromium complex is also not an intermediate in these cyclizations. Labeling and kinetic isotope experiments using partially deuterated derivatives of 1 further discredit benzyne complexes as intermediates in the formation of 2. The reaction of trimesityltris(tetrahydrofuran)chromium(III) with 2-butyne to form cis-2-mesitylbut-2-ene suggests that an initial step in these reactions may be insertion of 2-butyne into a carbon–chromium bond with formation of an intermediate vinylic chromium reagent (7). The additional observations that 2-biphenylmagnesium bromide and trichlorotris(tetrahydrofuran)chromium(III) react to form 5-(2-biphenyl)dibenzchromole (8), and that this chromocycle reacts with 2-butyne to yield 9,10-dimethylphenanthrene, implicate an analogous chromocycle 3,4-dimethyl-5-phenylbenzchromole (9) in the formation of 2. Taken together with further deuterium exchange and labeling experiments, these observations lead to the proposal that the reaction of 1 with 2-butyne proceeds by initial insertion of one molecule of 2-butyne into a phenyl–chromium bond of 1, cyclization of the resulting vinylic chromium compound with elimination of benzene to form chromocycle (9), and reaction of the chromocycle with a second molecule of 2-butyne to yield 2. (auth)

46237 MECHANISMS OF THIAMINE-CATALYZED REACTIONS. A KINETIC ANALYSIS OF THE DECARBOXYLATION

OF PYRUVATE BY 3,4-DIMETHYLTHIAZOLIUM ION IN WATER AND ETHANOL. Crosby, John; Lienhard, Gustav E. (Harvard Univ., Cambridge, Mass.). J. Amer. Chem. Soc.; 92: 5707-16 (23 Sep 1970).

The kinetics of the hydrogen–deuterium exchange of 3,4-dimethylthiazolium ion (1) in ethanol and the kinetics of the breakdown of 2-(1-carbethoxy-1-hydroxyethyl)-3,4-dimethylthiazolium ion (4) and of 2-(1-hydroxyethyl)-3,4-dimethylthiazolium ion (3) to form (1) and ethyl pyruvate or acetaldehyde, in ethanol and in water are reported. All three reactions are catalyzed by lyate ion. The rate constants for catalysis by ethoxide ion in ethanol are: for the hydrogen–deuterium exchange reaction of (1)-2-d, 4.6×10^3 M^{-1} min^{-1} at 25°C; for the breakdown of (4), 2.6×10^3 M^{-1} min^{-1} at 44.6°C; for the breakdown of (3) 1.1×10^5 M^{-1} min^{-1} at 45.6°C. The lyate ion catalyzed hydrogen–deuterium exchange of (1)-2-d occurs 500 times more rapidly in ethanol than in water. The lyate ion catalyzed elimination reactions of (3) and (4) are 10^4 to 10^5 times faster in ethanol than in water. Also, the addition of (1) to the keto group of ethyl pyruvate to form (4), the equilibrium constant for which is 20 M^{-1} in ethanol at 25.9°C, probably is about 10^4 times faster in ethanol than in water when the rates are compared at the same concentration of lyate ion. In conjunction with earlier work, these results provide a kinetic analysis of the decarboxylation of pyruvate by (1) and provide further support for the hypothesis that catalysis in thiamine pyrophosphate dependent enzymatic reactions may be due in large part to binding of the thiazolium nucleus in a hydrophobic region of the enzymes. (auth)

46238 FACILE HYDROGEN ISOTOPE EXCHANGE AS EVIDENCE FOR AN α-NITROSAMINO CARBANION. Keefer, Larry K.; Fodor, Connie H. (Univ. of Nebraska, Omaha). J. Amer. Chem. Soc.; 92: 5747-8(23 Sep 1970).

The base-catalyzed exchange of the 2- and 6-methylene protons of 1-nitroso-4-methylpiperazine with deuterium by exposure to 1.3 M sodium deuterioxide in deuterium oxide at 100°C is reported. The reaction is definitely base catalyzed and does not proceed to any measurable extent in either neutral or acidic media. (D.H.M.)

46239 PEPTIDE RACEMIZATION MECHANISM. A KINETIC ISOTOPE EFFECT AS A MEANS OF DISTINGUISHING ENOLIZATION FROM OXAZOLONE FORMATION. Kemp, D. S.; Rebek, Julius Jr. (Massachusetts Inst. of Tech., Cambridge). J. Amer. Chem. Soc.; 92: 5792-3(23 Sep 1970).

A method is described for assessing the kinetic isotope effect observed for the racemization of α-deuterated benzoyl-L-leucine and benzyloxycarbonylglycyl-L-phenylalanine, which occurs during coupling with ethyl glycinate. (D.H.M.)

46240 SULFONIUM SALTS. IV. CLEAVAGE-α-SUBSTITUTION COMPETITION OF DIBENZYLHALOSULFONIUM SALTS. Wilson, G. Edwin Jr.; Huang, Muh Guey (Polytechnic Inst. of Brooklyn). J. Org. Chem.; 35: 3002-7(Sep 1970).

Benzyl sulfide reacts with chlorine, bromine, N-Chlerosuccinimide (NCS), and N-bromosuccinimide (NBS) to provide α-halobenzyl benzyl sulfide, benzyl halide, benzylsulfenyl halide, and, where possible, N-benzylsulfenylsuccinimide. The competitive isotope effects, measured in deuteriochloroform and carbon tetrachloride, are consistent with an E2-type elimination from an initially formed halosulfonium salt. The variation of the ratio of cleavage to α-halogenated products is consistent with a rate-determining step involving halide ion attack on a single intermediate when initial concentrations of halogen and sulfide are low, but involving decomposition of aggregates when initial concentrations above about 0.3 M are used. (auth)

46241 ALKALOIDS OF REMIJIA PURDIEANA WEDDERLY AND THE HYDROGEN DEUTERIUM EXCHANGE OF METHYL ISOTHIAZOLES. White, James Arthur. Logan, Utah; Utah State Univ. (1969). 140p.

Thesis.

The alkaloid content of the bark of Remijia purdieana Wedderly has been investigated, and in addition to 7 alkaloids previously reported isolated, epicinchonamine, which has not previously been found to occur naturally, was found. The structure was assigned by comparison with cinchonamine and spectral methods. A synthesis of cinchonamine was attempted from methyl-5-quinuclidone-2-carboxylate. All of the methods utilized failed to attach a suitable substituent in the 5-position of methyl-5-quinuclidone-2-carboxylate or similar compounds. A detailed investigation of the mass spectral fragmentation of cinchonamine is given. The rate of hydrogen–deuterium exchange in the methyl group of 3-methyl; 4-methyl; 5-methyl; and 3,5-dimethylisothiazole was determined and compared with the rate of hydrogen–deuterium exchange of 2-methylpyridine. The rates of reaction were determined in dimethyl sulfoxide-d_6/D_2O using sodium deuteroxide as a basic catalyst. The relative rates were 5 > 3 > 4. Activation parameters were determined for 5-methyl-isothiazole. (Diss. Abstr. Int., B)

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Refer also to abstracts 46289, 46290, 46314, 46319, and 46586.

46242 (AAEC/TM–540) RADIATION INDUCED GRAFT POLYMERISATION OF STYRENE TO PAPER. Moore, P. W. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1970. 24p. Dep. CFSTI (U. S. Sales Only).

Pure cellulose filter paper and a cheap brown paper made from Eucalypt pulp were grafted with styrene by methods similar to those used for graft polymerisation of cellulose textiles. Grafting occurred more readily to the filter paper than to the brown paper, and much higher degrees of grafting were obtained by irradiating filter paper in monomer solution than by pre-irradiating the paper prior to soaking in monomer solutions. The relationship between the amount of grafting obtained and various parameters such as irradiation dose, monomer concentration, time, and temperature, which control the reaction, was determined. All grafted papers retained their flexibility and the appearance of paper, while those containing unextracted homopolymer were hard and brittle. Improved wet and dry tensile strengths were obtained with low degrees of grafting, but higher grafts caused excessive swelling of the fibres, which resulted in low-strength papers. Adaptation of the process to commercial production is discussed briefly. (auth) (Australia)

46243 (CNEA-267) DEVELOPING ^{99m}Tc GENERATORS. Karpeles, Alfredo; Palcos, Maria Cristina (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 1970. 16p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

A description is given of a simple and improved technique to isolate and purify ^{99}Mo ($T_{½}$ = 67.2 hours) from fission products, obtained from uranium dioxide irradiated with thermal neutrons. A semi-remotely operated equipment was designed to work safely with 1 Ci of fission products. The irradiated sample was dissolved in a closed reactor and the gases evolved were washed and partially fixed in alkaline traps and activated charcoal, being thus recovered. Molybdenum was separated from the solution by adsorption on alumina and purified by ion exchange to isolate it from other fission products. Finally, it was fixed on a chromatographic column (generator), from which the daughter, ^{99m}Tc($T_{½}$ = 6.0 hours), was eluted selectively carrier-free and with high specific activity, as required for medical applications. The impurity percentages were determined at different stages with radioactive tracers (^{95}Zr; ^{106}Ru; ^{131}I). With this technique it was possible to separate 60 mCi of ^{99}Mo each run, obtaining a chemical yield over 70% and a separation factor over 10^3. (auth)

46244 (COO–584–46) TECHNICAL PROGRESS REPORT, NOVEMBER 15, 1969–NOVEMBER 14, 1970. (Kansas State Univ., Manhattan). Contract AT(11-1)-584. 4p. Dep. CFSTI.

Experiments were performed on the spectra and photochemical reactions of mercury–ethylene matrices at 24 to 50°K. Studies on the mercury metastable gas chromatography detector were continued. An attempt is being made to develop a cold-cathode, electron emitter for electron radiolysis studies. Studies on reactions of both thermally generated tritium atoms and tritium species from gaseous discharges in the millitorr pressure range are in progress. The effects of surface area on the product yield of thermally generated tritium atoms are being investigated. (J.G.B.)

46245 (NP–18376) ON THE CHEMICAL FATE OF NASCENT ^{11}C ATOMS INDUCED BY IRRADIATION OF WATER AND AQUEOUS SOLUTIONS WITH 185-MeV PROTONS. Stenstroem, Tore (Uppsala Univ. (Sweden). Gustaf Werner Inst. Agricultural Coll., Uppsala (Sweden). Dept. of Radiobiology). Apr 1970. 198p. Dep. CFSTI (U. S. Sales Only).

Thesis.

Results of a study of the chemical fate of ^{11}C atoms induced in proton-irradiated water and aqueous solutions were interpreted in terms of hot reactions leading to primary ^{11}C products, assumed to be single-carbon molecules or radicals with yields independent of solute at low concentrations, and thermal reactions, in which the primary products react in the bulk of the solution with radioinduced radicals, or in the case of ^{11}C radicals, with a solute to give the observed ^{11}C end products. In carefully purified deaerated water, radioinduced oxidation of primary products yielded $^{11}CO_2$ as the only important product at high doses. In deaerated aqueous solutions, the reactions were found to be more complicated and ^{11}C radicals were oxidized or reduced, or combined with organic solute radicals to give products containing more than one carbon atom. Possible applications in the field of production of organic compounds labeled with ^{11}C are discussed. The chemical fate of ^{11}C induced in living tissues when high-energy radiation is used in radiotherapy is also discussed. (D.H.M.)

46246 (ORNL-tr-2293) A ^{188}Re GENERATOR USING ^{188}W. Blachot, J.; Herment, J.; Moussa, A. Translated by J. J. Pinajian and Lynda H. Kern (Oak Ridge National Lab., Tenn.), from Int. J. Appl. Radiat. Isotop.; 20: 467-70(1969). 7p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 31382.

46247 (ORNL-tr-2311) PREPARATION OF ^{198}Au, FREE OF ^{199}Au. Capgras, Andree (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated by J. J. Pinajian and Lynda H. Kern (Oak Ridge National Lab., Tenn.), from report CEA-R-3239. 10p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 2092.

46248 BIOLOGICAL SYNTHESIS OF AMP BY THE USE OF RECOILED ^{31}P ATOM WHICH COMES FROM THE β-DECAY OF ^{31}Si. Akaboshi, Mitsuhiko; Kawai, Kenichi; Waki, Asako (Kyoto Univ.). Dobutsugaku Zasshi; 79: 112-14(Apr 1970). (In Japanese).

Twenty-five mg of 70 to 90% enriched ^{30}Si (SiO_2) were irradiated in a hydraulic conveyer at a thermal neutron flux of $\sim 8.0 \times 10^{13}$ n cm^{-2} sec^{-1} for 10 hr. Immediately after irradiation, 5 μCi of ^{14}C-adenosine were added and allowed to decay all of the ^{31}Si for 2 days at room temperature. After this treatment, it was ascertained paper-chromatographically and radioautographically that, part of the ^{31}P recoil atoms were caught by adenosine molecules to yield 2' and/or 3' and 5'-AMP. The supposition that such an organic reaction might have occurred in the primordial earth is supported by the following facts. 1. Considerable amount of fast neutrons are present on the earth even today; 2. Water is a very effective thermalizing agent for fast neutron; and 3. Silica is the most abundant constitued of the soil. (auth) (Japan)

46249 PRODUCTION OF GRAFT POLYMERS OR COPOLYMERS BY THE USE OF RADIATION. Garnett, John Lyndon; Dilli, Sergio (to Unisearch Ltd.). U. S. Patent 3,522,158. 28 Jul 1970. Filed 21 Oct 1968.

A process for the production of graft polymers by ionizing radiation, in which a hydrophilic backbone polymer is irradiated in the presence of a solution of a monomeric vinyl compound polymerizable by free radical or ionic mechanism in a solvent is described. The solvent is selected from a specified group capable of swelling the backbone polymer to enable the monomer to gain access to active sites on the backbone polymer generated by radiation, which is carried out at a dose rate and with a concentration of monomer in the solvent which together produce a maximum amount of grafting for a given total dose rate. (Offic. Gaz.)

46250 APPLICATION OF RADIATION CHEMISTRY TO THE CHEMICAL INDUSTRY. Danno, Hirobumi (Japan Atomic Energy Research Inst., Takasaki). Sekiyu To Sekiyu Kagaku; 14: No. 2, 80-7(Feb 1970). (In Japanese).

The development of industrial application of radiation chemistry both in Japan and in other countries of the world, is reviewed. Radiation chemistry and radiation sources, radiation polymerization, radiation graft polymerization, modification by radiation, and radiation synthesis are all discussed. (Japan)

46251 METHOD OF MAKING A TACK-FREE SURFACE COATING UTILIZING HIGH ENERGY RADIATION. Miller, Lewis S. (to Weyerhaeuser Co.). U. S. Patent 3,520,714. 14 Jul 1970. Filed 28 Dec 1966.

A process is described for making a firm, tack-free polymer coating on surfaces using high-energy radiation by coating the surfaces with a liquid polymerizable composition, replacing the atmosphere surrounding the coating with an atmosphere of polymerizable monomer wholly in the vapor phase, and exposing the coating to high-energy radiation sufficient to polymerize the coating and polymerize the monomeric compound on the surface of the coating. (Offic. Gaz.)

46252 PREPARATION OF POLYOXYMETHYLENE USING HIGH ENERGY RADIATION. Marans, Nelson S.; Jaffe, Fred (to W. R. Grace and Co.). U. S. Patent 3,518,177. 30 Jun 1970. Filed 5 Jul 1966

High-molecular-weight polyoxymethylene is prepared by irradiating trioxane with high-energy ionizing radiation, and subsequently heating the irradiated trioxane below the melting point to achieve polymerization. (Offic. Gaz.)

46253 PRODUCTION OF ^{54}Mn AND ^{65}Zn FROM COPPER IN THICK TARGETS BY 0.45-GeV, 1.0-GeV, AND 3.0-GeV PROTONS. Van Ginneken, A.; Turkevich, Anthony (Univ. of Chicago). J. Geophys. Res.; 75: 5121-37(10 Sep 1970).

The production of ^{54}Mn and ^{65}Zn from copper was measured radiochemically at various depths and radial distances inside thick targets (up to 1 meter in size) that had been irradiated with 0.45-GeV, 1.0-GeV and 3.0-GeV protons. The targets consisted mainly either of copper or of iron. Based on the yields in these targets, the total number of ^{54}Mn atoms produced per incident proton in a semi-infinite body of copper is 2.9×10^{-2} at 0.45 GeV 7.5×10^{-2} at 1.0 GeV, and 2.0×10^{-1} at 3.0 GeV; the corresponding values for ^{65}Zn are 3.7×10^{-3}, 7.0×10^{-3}, and 1.9×10^{-2}. Results were compared with those of a Monte Carlo calculation that simulates the propagation of internuclear cascades in dense materials. The yields of ^{54}Mn and ^{65}Zn were computed as a function of location in the target from the particle fluxes given by the Monte Carlo calculation and from experimental excitation functions. The agreement is excellent for the production rates integrated over the target. It is generally good for the radially integrated dependence on depth but less satisfactory for detailed fits of the spatial distributions. Effects of finite beam size vis-a-vis the pencil beam of the calculation are discussed, and their inclusion was found to improve the detailed comparisons. The Monte Carlo calculation demonstrated the importance of internuclear cascade effects in thick targets: e.g., at 3.0 GeV about 90% of the ^{54}Mn and virtually all the ^{65}Zn is made by other particles than the primary ones. An analysis is presented of the different mechanisms by which a specific product can be made when high-energy particles enter large bodies, and the relative contribution of each of these mechanisms to the production of ^{65}Zn and ^{54}Mn in copper is evaluated. (auth)

46254 CHEMICAL BEHAVIOR OF ^{115}Cd RECOIL ATOMS IN NEUTRON IRRADIATED CADMIUM PHTHALOCYANINE. Kudo, Hiroshi; Yoshihara, Kenji (Japan Atomic Energy Research Inst., Tokai). J. Inorg. Nucl. Chem.; 32: 2845-51(Sep 1970).

The chemical behavior of ^{115}Cd recoil atoms in cadmium phthalocyanine, which was irradiated at dry ice temperature in a nuclear reactor, was studied by the use of the daughter-tracing technique. It was found that the thermal annealing processes could be divided into two stages, the activation energies being 0.12 ± 0.05 eV for stage I and 0.40 ± 0.05 eV for stage II, respectively. By comparing with copper and zinc phthalocyanines it was suggested that the nature of the bonding between the central metal atom and the ligand in the complex was one of the most important factors in determining the chemical fate of the recoil atoms. (auth) (UK)

46255 RADIATION DECOMPOSITION OF METASTABLE BARIUM–CALCIUM SULPHATE. Moravec, J.; Vojtech, O. (Inst. of Nuclear Research, Rez, Czech.). Radiochem. Radioanal. Lett.; 4: 271-5(31 Aug 1970).

The effects of γ radiation on the stability of $BaSO_4-CaSO_4$, a selective strontium sorbent, were examined. Radiation doses up to 5×10^9 Rad caused a gradual decomposition of the isomorphous structure of barite type into the individual structures of original components composing the system barite and anhydrite. Some anhydrite reacted with air moisture during decomposition and gave rise to $CaSO_4 \times \frac{1}{2} H_2O$. (auth)

46256 GAMMA RADIOLYSIS OF ALKALINE LIGHT AND HEAVY ICE CONTAINING CH_2ClCOO^- IONS. Kroh, J.; Stradowski, C. (Inst. of Radiation Chemistry, Lodz, Poland). Radiochem. Radioanal. Lett.; 4: 265-70(31 Aug 1970).

The isothermal decay of trapped electrons, e^-, in alkaline light and heavy ices was investigated. A correlation was found between the decay rate constant and the scavenger concentration. Spur radius is discussed in relation to the influence of a scavenger on e_t^- decay. (auth)

46257 INVESTIGATION OF THE RESISTANCE OF CHROMIUM PHOSPHATE ION EXCHANGER AGAINST RADIATION. Zsinka, L.; Szirtes, L.; Stenger, V. (Inst. of Isotopes, Budapest). Radiochem. Radioanal. Lett.; 4: 257-63(31 Aug 1970).

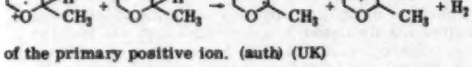
The changes of solubility, specific surface area, and the thermochemical and ion exchange properties of chromium phosphate were examined as a function of the γ or neutron radiation dose. It was found that the capacity increased after irradiation. Some ideas are given for explaining this fact. (auth)

46258 CHEMICAL CONSEQUENCES OF NEUTRON ACTIVATION IN BROMOBENZENES. I. Siekierska, K. E. (Danish Atomic Energy Commission Research Establishment Risoe, Roskilde); Millman, M.; Fenger, J. Radiochem. Radioanal. Lett.; 4: 251-6(31 Aug 1970).

Preliminary measurements of the distribution of ^{82}Br-activity in neutron-irradiated solid bromobenzenes showed in all cases the formation of an unidentified fraction accounting for almost half the activity. More detailed studies on p-dibromobenzene showed that the yield of this fraction is solvent and concentration dependent, and that it contains at least two different species. (auth)

46259 NATURE OF THE PRECURSORS OF HYDROGEN AND FREE RADICALS IN THE RADIOLYSIS OF GLASSY 2-METHYL-TETRAHYDROFURAN. Chachaty, Claude; Forchioni, Alain; Desalos, Jacques; Arvis, Michel (CEN, Gif-sur-Yvette, France). Int. J. Radiat. Phys. Chem.; 2: 69-80(Aug 1970). (In French).

Glassy 2-methyltetrahydrofuran (MTHF) was γ irradiated at 77°K in the presence of several electron scavengers. The hydrogen yield, $G(H_2)$, was close to the ionization yield and to that of the radicals CH_3. $G(H_2)$ was the same whether the electrons were scavenged or remained trapped in MTHF. The results were interpreted by the reaction



of the primary positive ion. (auth) (UK)

46260 INVESTIGATION OF GAMMA-RAY INDUCED POLYMER FORMATION IN THE CARBORANES. I. SEPARATION AND STRUCTURAL IDENTIFICATION OF THE POLYMER FORMED FROM 1-VINYL-o-CARBORANE. Wright, J. R.; Klingen, T. J. (Univ. of Mississippi, University). J. Inorg. Nucl. Chem.; 32: 2853-61(Sep 1970).

Investigation of the gamma irradiation of 1-vinyl-1,2-dicarbocloso-dodecaborane (1-vinyl-o-carborane) has shown that this material, which apparently exists in a type of mesomorphic or waxy state at room temperature, was polymerized in relatively high yield (~50%) without the formation of detectable side products at 31°C. Thin-layer chromatography and elution column chromatography were used to separate the unreacted monomer, the pure dimer, trimer, and tetramer from the higher polymeric products in sufficient quantity to allow the basic structural unit of the polymer to be elucidated. The polymer was found to be the linear "head to tail" type of structure formed through the vinyl carbons, which became saturated, and boron atom positions 9 and/or 12 of the polyhedral cage. Also each polymer unit was found to retain one vinyl end group. (auth) (UK)

46261 SOLID PHASE RADIOLYSIS OF CYCLOHEXANE. Bouillot, Marie-Josephe (Laboratoire de Physico-Chimie des Rayonnements, Orsay, France). Int. J. Radiat. Phys. Chem.; 2: 117-18(Aug 1970). (In French).

The yields of H_2, C_6H_{10}, and $C_{12}H_{22}$ formed in the radiolysis of cyclohexane at 300, 195, 178, and 77°K were determined. It was found that $G(H_2)$ and $G(C_6H_{10})$ decreased with decreasing temperature, while $G(C_{12}H_{22})$ remained constant. (auth) (UK)

46262 RADIOLYSIS AT 77°K OF PURE n-PENTANE AND IN THE PRESENCE OF ADDITIVES. Bienfait, C.; Claes, P. (Univ. of Louvain, Belgium). Int. J. Radiat. Phys. Chem.; 2: 101-16(Aug 1970). (In French).

Pentane was irradiated in the solid phase at 77°K to doses ranging from 0.1 to 10 Mrad. The yields of all the products were dose dependent. The yields extrapolated to zero dose and expressed in molecules/100 eV were: $G(H_2) = 5.00$; $G(C_2 + C_3) = 1.22$; $G(C_5H_{10}) = 3.45$; $G(C_{10}H_{22}) = 0.92$. Pentadecanes were also produced during these irradiations; the corresponding yields could be measured only for high dose. A G-value of 0.02 molecule per 100 eV was found for 10 Mrad. The observed dose effect was attributed to reactions between unsaturates produced during the radiolysis and hydrogen atoms or radical ions $C_5H_{11}^+$ and to reactions between pentyl radicals trapped in the matrix and hydrogen atoms. These interpretations were verified by effects produced by various additives on the yields of the main products. The additives used were olefins (2-pentene, isobutylene, and propylene) and electron scavengers (carbon tetrachloride, and nitrous oxide). (auth) (UK)

46263 IONIC SPECIES IN IRRADIATED POLYETHYLENE AT 77°K. Campbell, D. (Royal Military Coll. of Science, Shrivenham, Eng.). J. Polym. Sci., Part B; 8: 313-18(May 1970).

Spectra of species in polyethylene γ irradiated at low temperature, which are bleached by ir light of wavelength >1000 nm and which may be attributed to positive ions, are reported. Low density Alkathene polyethylenes, WNC 18, XDK 62, XJK 64, WVG 23, a low density radiation polymerized polyethylene R.2, and two high-density polyethylenes, Phillips Marlex 6000 and Rigidex type 9, were studied. First derivative ESR spectra and their integrated spectra were recorded immediately after irradiation and following subsequent exposure to light 77°K. Irradiation of three of the low-density polymers in the presence of a positive ion scavenger brought about a marked decrease in the concentration of the triplet accompanied by an overall change in the spectra. The simultaneous decay of the triplet and the trapped electron signal led to the assumption that the triplet was possibly due to positive ion species. (J.G.B.)

46264 EPR SPECTRUM OF-2,2,2-BICYCLO-OCTYL RADICALS. MOLECULAR MOTIONS AND LONG DISTANCE COUPLINGS. Bonazzola, Lydia; Marx, Rose (CNRS, Orsay, France). Mol. Phys.; 19: 405-10(Sep 1970). (In French).

The EPR spectrum of bicyclo-octyl radicals obtained by γ-irradiation of solid bicyclo[2.2.2]octane was studied. Long range hyperfine interactions that were much larger than in simple hydrocarbon radicals were observed. The changes in line width as a function of temperature were compared to wide-band NMR results, and some complementary information on molecular motions in solid bicyclo[2.2.2]octane was deduced. (auth) (UK)

46265 ELECTRONS, IONS, AND EXCITED STATES IN THE PULSE RADIOLYSIS OF TETRAHYDROFURAN. Baxendale, J. H.; Beaumond, D.; Rodgers, M. A. J. (Univ. of Manchester, Eng.). Trans. Faraday Soc.; 66: 1996-2003(Aug 1970).

Pulse radiolysis of tetrahydrofuran (THF) gave a transient absorption at long wave-lengths which was attributed to the solvated electron. When pyrene or anthracene was present their anions were formed with immediate yields of 0.66 and 0.70 when measured on microsecond time scales. These are considered to give the free ion yield. On nanosecond time scales, immediate yields were much higher, and there was an initial rapid decay of the anion which was attributed to ion recombination in the spurs. Lithium aluminium hydride, even on microsecond time scales, gave increased initial anion yields and longer anion lifetimes. At high concentrations G(anion) = 2.6 was attained. This was considered to be the primary ion pair yield in liquid THF and agreed with that derived from γ-radiolysis measurements. Anthracene gave $G(A^-) = 0.1$ and $G(A^T) = 0.04$, values which did not vary with anthracene concentrations over the range $5 \times 10^{-4} - 10^{-2}$ M. (auth) (UK)

46266 RADICAL YIELD IN γ-IRRADIATED D_2O SOLUTIONS OF FREMY'S SALT. Mantaka, A. E. (Democritos Nuclear Research Center, Athens); Rakintzis, N. Th.; Stein, Gabriel. Int. J. Radiat. Phys. Chem.; 2: 97-100(Aug 1970).

The total radical yield in γ-irradiated heavy water was determined using deaerated solutions of Frémy salt $[ON(SO_3)_2^{2-}]$ in D_2O in the pD range ≈9.5 to 12.5. At pD ≈ 11, $G_{(D+e_{aq}^-+OD)} = 6.8 \pm 0.2$ compared with $G_{(H+e_{aq}^-+OH)} = 6.1$ found in light water. (auth)

46267 DIELECTRIC ABSORPTION IN POLYOXYMETHYLENE OBTAINED FROM TETRAOXYMETHYLENE CRYSTAL BY RADIATION INDUCED POLYMERIZATION. Tanaka, Akira; Uemura, Shinsaku; Ishida, Yoichi (Osaka Univ.). J. Polym. Sci., Part A-2; 8: 1585-97(Sep 1970).

In order to study the dielectric behavior of polyoxymethylene prepared by radiation-induced solid-state polymerization, large crystals of tetraoxymethylene (2 cm in diameter) were prepared by Bridgman's method and polymerized by γ-rays. The x-ray diffraction pattern of the polymer did not reveal the existence of a so-called amorphous region. In dielectric measurements, only one dielectric absorption was observed in the low-temperature region, while in the high-temperature region ϵ'' did not change up to about 120°C, where thermal decomposition started. When the specimen was stabilized by acetylating the endgroups in the solid state, ϵ'' did not change up to about 150°C. This dielectric absorption showed a significant anisotropy for the direction of an applied field. The dielectric absorption was much larger when the electric field was perpendicular to the fiber axis than when the field was parallel. The dielectric absorption was larger in a specimen which was estimated to be more imperfect according to DSC analysis. This leads to the conclusion that the dielectric absorption is attributable to defect regions. On the other hand, the dielectric absorption became larger with increasing numbers of terminal OH groups, and hence it is attributable to the response of the terminal OH groups. Moreover, the dielectric absorption was depressed by the acetylation of the OH groups in the solid state. It is, therefore, concluded that the dielectric absorption observed in polyoxymethylene prepared by solid-state polymerization of tetraoxymethylene is due to the response of terminal OH groups localized in defect regions. Polyoxymethylene crystallized from the melt gives an asymmetric low-temperature absorption. This asymmetry can be ascribed to the superposition of two relaxation processes. When its absorption curve is compared with that of the solid-state polymerized polymer, the low-temperature component can be assigned to crystal defects and the high temperature one to amorphous regions. (auth)

46268 PULSE RADIOLYTIC INVESTIGATION OF THE RATE CONSTANTS OF REACTION OF AMINES WITH OH AND e_{aq}^-. Getoff, N.; Schwoerer, F. (Max-Planck-Institut fuer Kohlenforschung, Muelheim, Ger.). Int. J. Radiat. Phys. Chem.; 2: 81-9 (Aug 1970). (In German).

The rate constants of the reactions of thirteen amines with OH radicals and with solvated electrons (e^-_{aq}) at different pH values were determined. The values k(OH + amines) at pH 4 were found to be 0.09×10^9 dm^3 mol^{-1} s^{-1} for methylamine and 32×10^9 dm^3 mol^{-1} s^{-1} for benzylamine and to depend on the number of carbon atoms in the amines. The values k(OH + amine) were smaller at pH 2 than at pH 4 or 7. At pH 11.8 the k(e^-_{aq} + amine) values of the amines which were studied were 0.4 to 2.6×10^6 dm^3 mol^{-1} s^{-1} except for isobutylamine (11.0×10^6 dm^3 mol^{-1} s^{-1}), allylamine (12×10^6 dm^3 mol^{-1} s^{-1}), benzylamine (34×10^6 dm^3 mol^{-1} s^{-1}) and phenylethylamine (20×10^6 dm^3 mol^{-1} s^{-1}). The solvated electrons reacted with the protonated amines twice to 1450 (benzylamine) times faster than with the non-protonated amines. The factors influencing the rate constants presented are briefly discussed. (auth) (UK)

46269 ELECTRON SPIN RESONANCE OF POLYMERS. Campbell, D. (Research Triangle Inst., Durham, N. C.). J. Polym. Sci., Part D; 4: 91-181(1970).

A review of electron spin resonance (ESR) studies of polymers is presented that includes basic principles of ESR; macroradicals in polymers; G-values; and radical pairs: $\Delta M = 2$ transitions. (193 references.) (D.H.M.)

46270 ONE-ELECTRON TRANSFER INITIATED POLYMERIZATION REACTIONS. I. INITIATION THROUGH MONOMER CATION RADICALS. Gaylord, Norman G. (Gaylord Associates, Inc., Newark, N. J.). J. Polym. Sci., Part D; 4: 183-244(1970).

A review is presented on one-electron transfer-initiated polymerization reactions wherein the electron transfer is from the monomer to a suitable electron-accepting molecule; i.e., initiation through monomer cation radicals. Topics include: transfer to organic electron acceptors; transfer to metal salts; transfer to other inorganic acceptors; transfer to cations; transfer to cation radicals; transfer to cation salts; transfer to radicals; initiation by molecular dipoles; radiation induced initiation (irradiation of monomer and irradiation of monomer-catalyst charge-transfer complex). (124 references.) (D.H.M.)

46271 PHOTOLYSIS AND RADIOLYSIS OF POLYVINYL ACETATE. David, C.; Borsu, M.; Geuskens, G. (Univ. Libre, Brussels). Eur. Polym. J.; 6: 959-63(1970).

Quantum yields for chain scission and crosslinking were measured for the photolysis of polyvinyl acetate (PVA) as well as the G-values for the radiolysis of the polymer. It was found that 2537 Å light was about four times more efficient than γ rays in producing chain scissions and cross-linking in PVA. The presence of oxygen reduced quantum yields for both processes. (auth)

46272 GAMMA-RADIATION EFFECTS ON POLYMERS. II. POLY(ETHYLENE TETRACHLORO-o-PHTHALATE) IN DIOXANE SOLUTIONS. Ghanem, N. A. (National Research Centre, Cairo); El-Azmirly, M. A.; Aly, M. I. Eur. Polym. J.; 6: 1005-13(1970).

Poly(ethylene tetrachloro-o-phthalate) was irradiated in various concentrations in dioxane in a ^{60}Co cell. No degradation or crosslinking of the main chains was observed up to a dose of 236 · 448 Mrad. The predominant effect was the rupture of the carbon–halogen bond and the capture of most of the halogen by hydrogen to give HCl. Experimental evidence showed that hydrogen is extracted from the ethylene glycol part of the polyester by intramolecular reactions and from the solvent. NMR measurements showed probable alkylation of the aromatic part by reactive intermediate radiolysis products of dioxane. (auth)

46273 UNSTABLE INTERMEDIATES. PART LXXVII. PARAMAGNETIC CENTRES IN γ-IRRADIATED HYDROGEN CHLORIDE AND CAESIUM HYDROGEN CHLORIDE. Catton, R. C.; Symons, M. C. R. (Univ. of Leicester, Eng.). J. Chem. Soc., A; No. 13, 2255-8(1970).

Studies revealed that the radical ion Cl_2^- is a major product of radiolysis of the title compounds at 77°K. The marked reduction in $g_\perp$ compared with those for V_K centres in alkali-metal and alkaline-earth metal halides showed that Cl_2^-, especially in solid hydrogen chloride, is strongly hydrogen bonded. Hydrogen atoms are formed in good yield in $CsHCl_2$, but not in HCl. However, the hyperfine coupling of 495 G is unusually low and the g-value (2.0050) unusually high. These results and the linewidths (ca 17 G) were interpreted in terms of weak bonding to neighboring chlorine atoms. Of the other magnetic species formed, the most interesting was characterized by a well resolved 109 G doublet obtained from irradiated HCl. This was found by use of DCl to be due to coupling to a single proton. A similar doublet, having a subsidiary structure consisting of four lines separated by ca 10 G was partially concealed by the main doublet. After removal of the irradiated HCl, a broad doublet was again given with a (H) ca 139 G. It is postulated that these radicals are of the form $HSi(OH)_2$, $HSiCl(OH)$, and $HSi(O^-)_2$. The mechanism of radiation damage is discussed. (auth) (UK)

46274 ROLE OF EXCITATION IN RADIOLYTIC TRANSFORMATIONS OF AQUEOUS SOLUTIONS. Fiti, Maria (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 649-62 (1970).

The dependence of radical yields on solute concentration was investigated for the following systems: $KI-NaNO_3$, $NaNO_3-Na_2HPO_3$, $KH_2PO_4-Na_2HPO_3$, $KH_2PO_4-HCOONa$, $KH_2PO_4-CH_3OH$, and KH_2PO_4–2-propanol. Together with numerous literature data, the results are interpreted in terms of excited water (H_2O^*) participation in the chemical stage of radiolysis. This interpretation permits the calculation of the G-value of H_2O^* ($G^{ex}_{H_2O} = 0.50$) and its average life ($\tau_{H_2O^*} = 10^{-7}$ to 10^{-6} sec). The G-value is in agreement with Platzman's theoretical value and the value of $\tau_{H_2O^*}$ with that of Dainton and coworkers. (auth)

46275 ESR STUDIES ON PYROLYZED AND IRRADIATED POLYACRYLONITRILE. Hasegawa, Seiichi; Shimizu, Tatsuo (Kanazawa Univ., Japan). Jap. J. Appl. Phys.; 9: 958-63(Aug 1970).

ESR studies were carried out at temperatures from 77 to −196°C for polyacrylonitrile (PAN) pyrolyzed at temperatures up to 700°C and for one sample irradiated with ultraviolet light and γ rays. The ESR spectra for PAN pyrolyzed below 600°C were considered to be due to a free radical because they were independent of the measurement temperature. The g-values were found to decrease with increasing pyrolysis temperature and a possible explanation is proposed. The ESR spectra for PAN pyrolyzed above 650°C were sensitively affected by being exposed to air and change with the measurement temperature in a complicated way; the broad and narrow lines were observed and it may be speculated that the former and latter were due to a conduction electron and a free radical, respectively. For PAN irradiated with ultraviolet light and the one with γ rays, hyperfine structure (hfs) was observed in the ESR spectra in contrast with those for pyrolyzed PAN. The hfs lines were well explained by two types of free radical likely to be produced. (auth)

46276 RADIATION CHEMISTRY OF TETRAMETHYLSILANE. I. VAPOR PHASE. Mains, Gilbert J.; Dedinas, Jonas (Carnegie-Mellon Univ., Pittsburgh). Contract AT(30-1)-2007. J. Phys. Chem.; 74: 3476-82(17 Sep 1970).

The radiolysis of tetramethylsilane (TMS) induced by 50-pkeV x rays was investigated in the dose range 9.53×10^{15} to 4.20×10^{17} eV/ml and at pressures of 60 to 300 Torr. Reaction mechanisms were deduced from studies using 1:1 TMS–$TMS\text{-}d_{12}$ mixtures and from experiments in which O_2 and NO were added as free radical scavengers. H_2 and CH_4 were produced by atomic reactions, molecular elimination reactions, and, to a lesser extent, by "hot" intermediates. C_2H_6 was formed almost exclusively via methyl radical combination. Internal free radical scavengers, C_2H_2, C_2H_4, and C_3H_4, were radiolysis products and observed in appreciable G yields at low conversions or in the presence of O_2 or NO. The principal carbosilane products were $(C_2H_3)Si(CH_3)_3$, $(CH_3)_3SiSi(CH_3)_3$, $(CH_3)_3SiCH_2Si(CH_3)_3$, and $(CH_3)_3SiCH_2CH_2Si(CH_3)_3$, all of which appear to arise from the intercombination of $CH_3\cdot$, $(CH_3)_3Si\cdot$, and $(CH_3)_3SiCH_2\cdot$ radicals. A diradical intermediate, $(CH_3)_3SiCH_2\cdot$ was also postulated to account for radiolysis products obtained in small yields. (auth)

46277 RADIATION CHEMISTRY OF TETRAMETHYLSILANE. II. LIQUID PHASE. Mains, Gilbert J.; Dedinas, Jonas (Carnegie-Mellon Univ., Pittsburgh). Contract AT(30-1)-2007. J. Phys. Chem.; 74: 3483-6(17 Sep 1970).

The radiolysis of tetramethylsilane (TMS) liquid induced by 50-pkeV x rays was investigated at 25° in the dose range 0.713×10^{20} to 3.56×10^{20} eV/ml and compared with the previously reported vapor phase radiolysis study. The condensed phase was found to enhance the hydrogen abstraction reaction of methyl radicals resulting in an increased yield of methane, $G(CH_4) = 4.8$, and $(CH_3)_3SiCH_2CH_2Si(CH_3)_3$ and $(CH_3)_3SiCH_2Si(CH_3)_3$ products. Correspondingly, the yields of ethane and ethyltrimethylsilane are reduced in the liquid phase. The yields of internal scavengers, C_2H_4, C_2H_2, and C_3H_4, are 50 to 100 times lower in the liquid phase, suggesting an electronically excited precursor. Nonhomogeneous radical distribution is suggested to account for product formation in the presence of scavengers. (auth)

46278 CHEMILUMINESCENCE AND THERMOLUMINESCENCE FROM A gamma-IRRADIATED SILICA–ALUMINA GEL. Hentz, Robert R.; Ziemecki, S. B. (Univ. of Notre Dame, Ind.). J. Phys. Chem.; 74: 3552-4(17 Sep 1970).

A study was made of the exposure of irradiated silica–alumina gel to H_2, NO, NO_2, NH_3, H_2S, C_2H_4, C_2H_2, and O_2. Each of the reagents, with the exception of O_2, produced luminescence on contact with the irradiated gel. When the irradiated gel was heated above 100°C, thermoluminescence was observed concomitant with the disappearance of the visible coloration and the ESR signal of the Al positive-hole center. However, there was a distinct difference between the thermoluminescence and chemiluminescence spectra that does not appear attributable to an effect of self-absorption. (D.H.M.)

46279 YIELD OF THERMAL HYDROGEN ATOMS FROM THE gamma RADIOLYSIS OF LIQUID 2,2,4-TRIMETHYLPENTANE Bansal, Krishan M.; Rzad, Stefan J. (Carnegie-Mellon Univ., Pittsburgh). J. Phys. Chem.; 74: 3486-90(17 Sep 1970).

In the γ radiolysis of 2,2,4-trimethylpentane, the decrease in the hydrogen yield observed upon the addition of ethylene is equal to the yield of ethyl radicals. This result is interpreted in terms of simple scavenging of thermal hydrogen atoms by ethylene since complications arising from the positive ion reactions of the latter do not appear to occur. The lack of ionic complications in this system is also supported by the absence of positive ion reactions with cyclopropane. A treatment of the data accordingly gives a yield of thermal hydrogen atoms ($G(H)_\theta$) of 1.0 and a ratio of rate constants for the abstraction of hydrogen atom from the solvent to the addition to ethylene of 0.0043. (auth)

46280 FURTHER OBSERVATIONS ON PRODUCTS FORMED IN THE RADIOLYSIS OF ALKALI METAL HALATES AND PERHALATES BY ^{60}Co gamma RAYS. Boyd, G. E.; Brown, L. C. (Oak Ridge National Lab., Tenn.). J. Phys. Chem.; 74: 3490-7(17 Sep 1970).

Spectroscopic and chemical techniques were employed to identify and measure the concentrations of the stable radiolytic products formed at room temperature in crystalline $KClO_3$, $CsBrO_3$, $CsIO_3$, $KClO_4$, $KBrO_4$, and KIO_4 by ^{60}Co γ rays. The ultraviolet absorptions of $KClO_3$ and $CsBrO_3$ measured with diffuse reflectance techniques indicated the presence of ClO^-, ClO_2^-, O_3^-, and BrO^- and O_3^- ions, respectively, in these solids. The spectrum of heavily irradiated $CsIO_3$, however, showed no new features except for a broad band at 460 nm attributable to I_2 in the crystal. The infrared absorptions of $KClO_4$, $KBrO_4$, and KIO_4 showed that ClO_3^-, ClO_2^-, BrO_3^-, IO_3^- ions, respectively, were formed by radiolysis. Chemical determinations of the amounts of BrO^-, BrO_2^-, and BrO_4^- ions produced in $CsBrO_3$ by increasing γ-ray exposure revealed that constant concentrations were approached for large doses, suggesting that decomposition reactions of a thermal and/or radiolytic nature must occur. The rate of increase in the BrO^- ion concentration at very low dose suggested that this species is not a primary radiolysis product. The excess oxidizing power of $CsBrO_3$ above that from hypobromite and bromite ions was attributed to O_3^- ion rather than to BrO_2 as assumed earlier. A synopsis of the current state of knowledge about the radiolysis of halate ions in crystals is given. (auth)

46281 REACTIONS OF ENERGETIC ^{18}F ATOMS WITH TETRAFLUOROETHYLENE. Smail, Thomas; Miller, George E.; Rowland, F. S. (Univ. of California, Irvine). Contract AT(11-1)-34. J. Phys. Chem.; 74: 3464-71(17 Sep 1970).

Energetic ^{18}F atoms react with $CF_2=CF_2$ to form $CF_2=CF^{18}F$ and $CF_2CF_2{}^{18}F^*$. More than 89% of $CF_2=CF^{18}F^*$ molecules are excited enough to decompose to CF_2 plus $CF^{18}F$ (>76 kcal/mol excitation energy) at several atmospheres pressure; $CF^{18}F$ is conveniently trapped by insertion in HI to form $CHF^{18}FI$. The decomposition of excited $CF_2CF_2{}^{18}F^*$ by C–C bond rupture is followed by measurement of $CHF_2CF_2{}^{18}F$ and $CHF_2{}^{18}F$ yields in the presence of HI. The half-stabilization pressure for $CF_2CF_2{}^{18}F$ radicals formed by thermal ^{18}F atom addition is 218 Torr of C_2F_4. The formation of ^{18}F in gas ampoules by the $^{19}F(n,2n)^{18}F$ reaction was monitored with a system utilizing a Teflon sleeve around the standard glass ampoule. The average recoil range of ^{18}F from the (n,2n) reaction is about 0.1 cm in 760 Torr of C_2F_4. (auth)

46282 RECOIL TRITIUM REACTIONS WITH METHANE AND CYCLOHEXENE. Weeks, Robert Wiley Jr. Columbia, Mo.; Univ. of Missouri (1969). 151p.

Thesis.

The reaction of high energy tritium generated through the $He^3(n,p)T$ reaction for gas phase studies and through the $Li^6(n,\alpha)T$ reaction for liquid phase studies were studied in the gas phase and liquid phase for cyclohexene, and for the gas phase along in methane. Additionally the noble gases He, Kr, or Xe were used to moderate some cyclohexane samples and He alone was used to moderate some methane samples. Using the noble gases gave two effects. The first was to cause a distribution of tritium energies through a series of elastic collisions. The second effect was to furnish an environment in which charge transfer reactions either could or could not occur. Thus, because of its high ionization potential He was unique, among the noble gases studied, in allowing the T^+ ion to persist. In cyclohexene samples HT, ethene-t, 1,3-butadiene-t, n-hexene-t, cyclohexane-t-, methylcyclohexane-t, cyclohexene-t, propene-t, an unidentified tritiated product and tritiated polymeric material were observed. Of these, HT, methylcyclohexane-t and certain tritiated polymeric materials were proposed to have resulted at least partially from ionic precursors. Cyclohexane-t was likely formed by tritium addition to the cyclohexene double bond and subsequent H abstraction by the resultant cyclohexyl-t radical. This process would proceed by a low energy pathway and such was corroborated by increasing cyclohexane yield as the moderator/hydrocarbon ratio increased. The fraction of the total observed activity which appeared as cyclohexane-t became lower as the mole fraction of moderating gas increased. According to the Wolfgang–Estrup theory of hot atom reactions this behavior is such as would be expected for products formed by hot processes. An energy model for the unimolecular decomposition of cyclohexene to ethylene and butadiene was proposed. This showed a wide range of excitation energies whose values ranged from 4.5 to 13.6 eV/molecule. Relative efficiencies for deactivating the cyclohexene molecule before decomposition were He = 0.05, Kr = 0.18, Xe = 0.19 and cyclohexene = 1.00. Both cyclohexane-t and n-hexene-t could have the cyclohexyl-t radical as a precursor. The ratio of the yields of these products was observed to be a function of both the pressure of the system and the mole ratio [moderating gas]/[hydrocarbon]. In methane samples a decrease in CH_3T as a fraction of the total observed activity as the moderator fraction increased showed that methane-t was formed primarily through a hot process. The other products formed, HT, C_2-t, C_3-t, and tritiated polymers, showed increased yield as the moderator/hydrocarbon ratio increased. Ionic pathways could account for this observation. (Diss. Abstr. Int., B)

46283 APPLICATION OF GAMMA RADIATION TO SEWAGE TREATMENT. Woodbridge, David D. (Energy Systems, Inc., Melbourne, Fla.); Mann, Leland A.; Garrett, William R. Nucl. News; 13: No. 9, 60-4(Sep 1970).

A sewage treatment plant near Palmdale, Fla. has been in operation using γ radiation to treat the sewage since March, 1970. The plant is described in detail; average analyses of samples are presented; and cost estimates both for construction and long range maintenance and operation are presented. (B.L.M.)

46284 RADIATION CROSSLINKING OF POLYMERS WITH SEGREGATED METALLIC PARTICLES. Kusy, R. P.; Malliaris, A.; Turner, D. T. (Drexel Inst. of Tech., Philadelphia). Nucl. News; 13: No. 9, 54-7(Sep 1970).

Electrically conductive plastics can be prepared by the inclusion of finely divided particles of metal in plastic. Suitable mixtures are as little as 6 vol % of finely divided Cu or Ni included in the plastic. The composites lose electric conductivity upon heating, and heat stability can be imparted to compacts made of nylon and polyethylene when they are crosslinked by exposure to γ radiation. (B.L.M.)

46285 REVIEW OF AEC PROCESS RADIATION PROGRAM. Rotariu, George J. (Atomic Energy Commission, Washington, D. C.). Nucl. News; 13: No. 9, 45-7(Sep 1970).

The research and development program of the Division of Isotopes Development of AEC for the purpose of accelerating development and expanding the scope of the radioisotope and radiation applications to serve the national interest is reviewed. The programs are carried out in three main areas: radiation synthesis of chemical products; radiation modification of certain materials, such as wood, concrete, and polymers; and support in radiation technology areas. One project, the "Wood-Plastics," has developed from the research stage through industrial acceptance. (B.L.M.)

46286 TREATING WASTEWATER AND SEWAGE SLUDGES WITH RADIATION: A CRITICAL EVALUATION. Compton, D. M. J. (Enviro-Med, Inc., La Jolla, Calif.); Black, Sandra J.; Whittemore, W. L. Nucl. News; 13: No. 9, 58-60(Sep 1970).

The effects of γ radiation on settling velocities and solid contents of the settled sludge were investigated on real waste water samples. Small effects were noted with radiation doses up to 10^5 rads, and similar effects can be produced by adding a polyelectrolyte at about ⅓ the cost. The effects of radiation on the filterability of sludges were investigated, and a marked effect was noted. However, the effect saturated at a radiation dose of 10^5 rads and at a level of specific resistance too high to permit the filtering of the sludges at a useful rate on a heavy rotary vacuum filter. It was concluded that within the limits of the parameters studied, the applicability of ionizing radiation to the treatment of municipal waste water and sludges is likely to be very limited. (B.L.M.)

46287 CONCRETE-POLYMER MATERIALS DEVELOPMENT. Steinberg, M.; Kukacka, L. E.; Colombo, P.; Manowitz, B. (Brookhaven National Lab., Upton, N. Y.). Nucl. News; 13: No. 9, 48-54(Sep 1970).

The development of concrete–polymer composites as new materials for construction was investigated at Brookhaven National Laboratory. Techniques were developed for the radioinduced preparation of the concrete–polymer material, for the measurement of the physical and chemical properties of the materials, for the preparation of full-scale concrete products, and for the conceptual design and evaluation of various specific applications. The choice of monomer is dictated by the end application of the materials. Polymerization techniques and properties of methyl methacrylate-impregnated concrete are presented. The properties of concrete–polymers are compared with ordinary concretes. (B.L.M.)

46288 RECOIL TRITIUM REACTIONS OF PROPENE AND ACETYLENE: SECONDARY AND PHASE EFFECTS. Mahan, Kent Ira. Columbia, Mo.; Univ. of Missouri (1969). 180p. Thesis.

Temperature, pressure, scavenger, radiation dose rate, and phase effects on the primary and secondary reactions of recoil tritium from the $^3He(n,p)^3H$ and $^6Li(n,\alpha)^3H$ nuclear reactions were studied in the propene system, while pressure and scavenger effects were studied in the acetylene system. Reaction pathways were elucidated from the nature, yield, and distribution of the labeled products found in the systems. Volatile products were analyzed by radio-gas chromatography using single and dual column techniques, while polymeric products were determined using solvent trapping and extraction techniques. Significant yields of HT, CH_3T, C_2H_3T, C_2HT, C_3H_7T, C_3H_5T, 2,3-dimethylbutane-t, 2-methylpentane-t, n-hexane-t, hexene-t's and labeled polymer were found in the propene system. All of these products except hexene-t were found in both the gas and liquid phase. Hexene-t was found only in the liquid phase system. The differences in the distribution of labeled products between the gas and liquid phase propene systems were shown to be a result of the de-excitation of highly excited radicals produced by the hot addition of T to C_3H_6 rather than phase effects on the primary hot reactions. Wall reactions and radiation dose rate were shown to be important in the production of HT. The major products of the recoil tritium–acetylene system were shown to be HT, C_2HT, benzene-t and polymer. The production of benzene-t was shown to proceed through a radical mechanism involving C–H bond rupture in the $C_6H_6T\cdot$ radical as a final step in the formation of the benzene molecule. Wall reactions were shown to be important sources of HT in both the propene and acetylene systems. The most interesting comparison of the reactions of the n-propyl-t and isopropyl-t radicals produced in the propene system to the vinyl-t radicals of the acetylene system was the observation of the stabilization of the vinyl-t radical over the pressure range studied (about 100 to 600 torr), while no pressure stabilization of the propyl-t radicals was observed in the gas phase over a similar range. (Diss. Abstr. Int., B)

Radiochemistry

46289 (NP-18402) CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS: BIBLIOGRAPHY 1969. Adloff, J. P. (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires). 37p. (In several languages). Dep. CFSTI (U. S. Sales Only).

This 1969 bibliography reviews 215 alphabetic references. A classified index of elements and isotopes and an alphabetic index of various authors' works are presented. (auth) (France)

46290 (NP-18403) CHEMICAL EFFECTS OF NUCLEAR TRANSFORMATIONS: BIBLIOGRAPHY, 1963–1967. Adloff, J. P. (Centre National de la Recherche Scientifique, Strasbourg (France). Centre de Recherches Nucleaires). 118p. (In several languages). Dep. CFSTI (U. S. Sales Only).

For this bibliography, 833 alphabetic references, 1963 to 1967, are reviewed. Radiation effects on the formation of chemical compounds and on the formation of defects eliminated by annealing are investigated. Some other studies are included in this scope: ion–molecule reactions at low energy, reactions of hot atoms produced by photochemical or thermal dissociation, special analytical methods, isotopic exchange studies for radionuclide separation with Szilard–Chalmers effect. A classified index of elements and isotopes and an alphabetic index of various authors' works are presented. (France) (auth)

46291 POLAROGRAPHIC STUDY OF RADIOISOTOPES: ^{155}Eu, ^{169}Yb, ^{153}Gd, ^{241}Am, ^{244}Cm, AND ^{252}Cf. David, Francois (Paris Univ., Orsay, France). Compt. Rend., Ser. C; 270: 2112-15(29 Jun 1970). (In French).

A method of radiochemical polarography was applied in perchloric medium at pH 1 to 6 to some 4f and 5f elements of the periodic table: Eu, Gd, Yb, Am, Cm, and Cf. Two waves were observed on the polarograms. The first one results from the reaction $M^{2+} \rightarrow M^0$. The second wave should result from the reaction $M^{3+} \rightarrow M^0$. (auth) (France)

46292 ELECTROCHEMICAL PROPERTIES OF RADIOACTIVE METALS. Spitsyn, V. I. (Inst. of Physical Chemistry, Moscow). Rec. Chem. Progr.; 31: No. 1, 27-41(1970).

Studies were made on the electrochemical behavior of radioactive Fe, Ag, and Zn in various solutions. The metals were irradiated in a nuclear reactor with a thermal neutron flux of 1.2×10^{13} neutrons/cm^2/sec. Results with HCl showed that during a 3-hr period, the dissolution rate of the radioactive iron increased somewhat. Quite a different regularity was observed with 5 N H_2SO_4 and $HClO_4$. The initial electrode potentials of radioactive iron in KOH were shifted to more positive values compared to the control, nonradioactive electrodes. As the specific radioactivity increased, the iron potentials became more positive; however, the extent of the observed potential shift gradually decreased. An even more distinct picture of the difference in electrochemical properties of radioactive and nonradioactive iron was obtained in a 1 N solution of $Fe(NO_3)_3$. From the results on radioactive Zn and Ag, it was concluded that the radiation does not substantially affect the potential of the metallic electrodes but does change the value of the potential of the oxidized metals. It was generally concluded that the electrochemical behavior of radioactive metals depends on a number of factors, including the properties of the surface semiconducting film and its interaction with electrolytes of various composition, which play an important role. (P.C.H.)

Separation Processes

Refer also to abstracts 46181, 46184, 46206, 46222, 46243, 46430, 46457, 46547, 47574, and 47808.

46293 (AAEC/TM-538) SEPARATION OF ZIRCONIUM AND HAFNIUM BY SOLVENT EXTRACTION: A LITERATURE REVIEW. Royston, D.; Alfredson, P. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Apr 1970. 24p. Dep. CFSTI (U. S. Sales Only).

The commercially important hexone–thiocyanate and TBP–nitric acid solvent extraction processes for the separation of zirconium and hafnium are examined in detail. The relative costs and merits of the two processes are discussed. A brief review of other solvent extraction processes is also presented. (auth) (Australia)

46294 (ANL-Trans-843) SEPARATION OF TRANSURANIUM ELEMENTS WITH THE AID OF GAS CHROMATOGRAPHY OF THEIR CHLORIDES. Zvarova, T. S.; Zvara, I. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by M. G. Chasanov (Argonne National Lab., Ill.), from report JINR-P6-4911. 7p. Dep. CFSTI.

The gas chromatographic separation of protactinium, uranium, neptunium, plutonium, americium, and curium was investigated using as the gas carrier a mixture of an inert gas with aluminum chloride vapors. (D.H.M.)

46295 (ARH-SA-74) SOLIDIFICATION AND IMPROVED TREATMENT OF LOW AND INTERMEDIATE LEVEL RADIOACTIVE WASTES AT HANFORD. Godfrey, W. L.; Hanson, G. L.; Smith, P. W. (Atlantic Richfield Hanford Co., Richland, Wash.). 5 Aug 1970. Contract AT(45-1)-2130. 16p. (SM-137/50; CONF-700905-2). Dep. CFSTI.

From Symposium on Developments in the Management of Low and Intermediate Level Radioactive Wastes, Aix-en-Provence, France.

Large scale production techniques used to solidify intermediate level radioactive liquid wastes and to improve the treatment of low and intermediate level radioactive liquid wastes at Hanford are discussed. Three types of evaporation units are used to concentrate intermediate level wastes to solids: a 650°C in-tank air sparger, a 4-megawatt in-tank electric immersion heater, and a thermosiphon evaporator. The hot air sparge unit operates semi-continuously to concentrate fresh feed to high viscosity and specific gravity for blending with feed to the electric immersion heater. Special off-gas treatment is required due to the large heated air flow. The electric immersion heater and the thermosiphon evaporator operate on a continuous recycle system, utilizing several 2.8×10^6 liter storage tanks in series for air cooling and salt accumulation. Salts are deposited from the cooled mother liquors and the supernatant solutions are mixed with fresh feed for recycle to the evaporators. When a cooled

tank is filled with solids the residual liquid is removed leaving an immobile salt cake. Several streams carrying cooling water effluents are being treated as part of a program to reduce the radioactivity routed to the ground to the lowest practicable quantity. Monitoring systems were installed for some liquid effluents, such as process cooling water and steam condensates which activate diversion to intermediate level disposal in case of an increase in radioactivity due to equipment failure or an accident. Intermediate level liquid wastes from laboratory facilities, nuclear reactor flushes, and decontamination of nuclear fuel processing equipment are evaporated to remove radioactivity prior to discharge to the soil. The more radioactive process condensates in the Purex nuclear fuels processing plant are recycled to the process. Condensates from high level waste, self-boiling storate tanks and the in-tank solidification units are recycled or treated by ion exchange to remove cesium-137. (auth)

46296 (BARC-457) DEVELOPMENT OF GRANULAR ION EXCHANGERS FROM NATURALLY OCCURRING INDIAN CLAYS: THEIR UTILISATION FOR DECONTAMINATION OF RADIOACTIVE LIQUID WASTES. Chandra, Umesh (Bhabha Atomic Research Centre, Bombay (India)). 1970. 17p. Dep. CFSTI (U. S. Sales Only).

Various powdery clays have been granulated for their use as ion exchangers in large columns for decontamination of radioactive liquid wastes. Binding agents like cement, starch, sodium silicate, and ethyl orthosilicate were tried to granulate the clays. However, it has been found that simple heat treatment of clay pellets, to 500 to 600°C, was an effective method for making the clays stable in electrolyte solutions. The pelletization has been carried out in the laboratory by a special mechanical extruder. Whereas a granulated attapulgite clay has been found to be useful for selective removal of radiocesium, the granulated bentonitic clay is suitable to decontaminate a waste containing fission products. (auth)

46297 (BARC-476) THE USE OF TRILAURYL AMINE AS AN EXTRACTING AGENT FOR PLUTONIUM(IV). Kumar, S. V.; Kapoor, S. C.; Jain, S. P. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 27p. Dep. CFSTI (U. S. Sales Only).

The distribution coefficients of plutonium (IV) have been determined in 20% trilaurylamine. The diluents used were Shell Sol T, Solvesso-100, and mixtures of Shell Sot T and Solvesso 100. A higher loading of plutonium in the trilaurylamine phase, without significantly lowering the distribution coefficient can be achieved by using a mixture of diluents with proper ratio of Shell Sol T and Solvesso-100. The variation of the distribution coefficient with acidity has also been studied. Acetic acid (3 M) was found to be a satisfactory agent for stripping plutonium from the loaded trilaurylamine phase. (auth)

46298 (BNWL-1494) RESEARCH AND DEVELOPMENT ACTIVITIES FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, May-July 1970. Blasewitz, A. G. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 24p. Dep. CFSTI.

To date, 30 radioactive demonstrations in WSEP have been completed with simulated wastes containing approximately 48 MCi of mixed radionuclides being converted to solids. During the report period, the thirteenth and final spray solidification demonstration run in WSEP was completed. A simulated PW-4m waste (a low salt, high fission product waste resulting from the reprocessing of a power reactor fuel with an exposure of 45,000 MWd/tonne at 30 MW/tonne) was successfully reduced to a solid having a heat rate density of 200 W/liter via the in-pot melting technique. Spray calcined PW-4m waste was melted directly with a borosilicate glass frit in the final storage container at a processing rate of about 1.1 tonne/day which is an 80% higher rate than was obtained for this waste type during previous spray solidification runs using the platinum melter. The fact that only 0.5% of the ruthenium in the feed processed was voltitilized from the spray solidifier during this run verifies the results of other runs which indicated that the ruthenium volatilization from the spray solidifier was significantly reduced when phosphoric acid was not added to the feed. (auth)

46299 (DOCKET-50201-42) WEST VALLEY REPROCESSING PLANT. Final Safety Analysis Report, Revision 6. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 31 Aug 1970. 28p. Dep. CFSTI.

Information is presented in support of the safety analysis for the West Valley Reprocessing Plant. A comprehensive program of geologic and seismologic studies was undertaken to determine whether significant geologic structures were present near the site, which could generate seismic disturbances. The seismicity of the region was evaluated to determine the relationship between historic earthquakes and known geologic structures. Design considerations for protection against earthquakes and tornadoes are discussed. (M.C.G.)

46300 (DOCKET-50201-44) WEST VALLEY REPROCESSING PLANT. Head End Ventilation System. Final Safety Analysis Report, Suppl. 3. (Nuclear Fuel Services, Inc., West Valley, N. Y.). 21 Sep 1970. 14p. Dep. CFSTI.

The effect of the failure of the facility due to an earthquake or a tornado would be to shut down the revised ventilation to the head-end cells. No major release of contamination would result either from the cells or from the contaminated filters. Control and operation of the system are discussed. Leak monitoring of the sump tank, DOP testing of the absolute filters, technical specifications, and down-stream screens are discussed. (M.C.G.)

46301 (DOCKET-50332-16) BARNWELL NUCLEAR FUEL PLANT. Safety Evaluation. (Division of Reactor Licensing (AEC), Washington, D. C.). 18 Sep 1970. 149p. Dep. CFSTI.

The principal plant features are discussed and safety considerations are evaluated. Topics covered include: site and environment, plant design and radiological safety, design of Class I structures and components, confinement systems, radioactive effluents and solid wastes, process instrumentation and control, protection systems, accident analyses, quality assurance, organization and technical qualifications, emergency planning, common defense and security, and financial qualifications. (M.C.G.)

46302 (DP-Report-338) STUDIES ON THE REPROCESSING AND REFABRICATION OF H.T.G.R. FUELS IN THE O.E.C.D. DRAGON PROJECT. Project DRAGON. Horsley, G. W.; Podo, L. A.; Wood, F. C. (Atomic Energy Establishment, Winfrith (England)). Apr 1965. 30p. Dep. CFSTI.

The aims of the Dragon Project fuel reprocessing studies are broadly outlined. Preliminary results of assessment and experimental studies on the head-end treatment of spent fuel elements commensurate with the centralized reprocessing requirements of an integrated HTGR power system of 10,000 MW(th) are presented. Proposals for the decontamination of irradiated Th/U fuels by solvent extraction at the rate of 60 to 70 kg (Th/U) per day to produce either uranyl nitrate solution for rapid fuel fabrication in a lightly shielded facility or thorium/uranyl nitrate solution for conversion to fuel in a heavily shielded facility, are presented and discussed. Relevant results of experimental studies on the preparation of particulate oxide and carbide fuels by powder metallurgical and sol-gel techniques are presented and schemes for the refabrication of such fuels from high enrichment uranyl nitrate and uranyl/thorium nitrate solutions are outlined. (auth)

46303 (GA-9258) HEAD-END SEPARATION OF TRISO-COATED FISSILE AND FERTILE PARTICLES FOR HIGH-TEMPERATURE GAS-COOLED REACTORS. Langer, S.; Baldwin, N. L.; Phillips, H. R. (Gulf General Atomic, Inc., San Diego, Calif.). Jun 1970. Contract AT(04-3)-167. 12p. Dep. CFSTI.

Preliminary studies indicated that the separation of ^{233}U from ^{235}U during head-end reprocessing of HGTR fuels of TRISO-coated (contains SiC layer) fissile and fertile particles is feasible. The SiC layer was strong enough to withstand pressure of fission gases at 800°C. Irradiation had a negligible effect on the integrity of the SiC layer. Uranium retention in alumina bed material was negligible. (J.G.B.)

46304 (GA-9888) HEAD-END SEPARATION OF BISO-COATED FISSILE AND FERTILE PARTICLES FOR HIGH-TEMPERATURE GAS-COOLED REACTORS. Langer, S.; Phillips, H. R. (Gulf General Atomic, Inc., San Diego, Calif.). Jun 1970. Contract AT(04-3)-167. 21p. Dep. CFSTI.

Studies were made on the separation of ^{233}U from ^{235}U based on the difference in stability of the oxide and carbide kernels. The fissile kernel containing ^{235}U is $^{235}UC_2$, while the ^{233}U fissile kernel and the fertile kernels are $(Th,^{233}U)O_2$ and ThO_2. Results of fluid and static bed oxidation experiments indicated that irradiation of oxide microspheres produces changes in the kernels that impair their physical stability under oxidizing conditions. Studies on both irradiated and nonirradiated particles demonstrated that a differential leaching process could not successfully separate ^{235}U in a $^{235}U_3O_8$ ash from the ^{233}U in fragmented $(Th,^{233}U)O_2$ kernels without an unacceptable isotopic mixing. (J.G.B.)

46305 (NLCO-1067) BENEFICIATION AND REFINING OF URANIUM CONCENTRATES. Leist, N. R. (National Lead Co. of Ohio, Cincinnati). 23 Apr 1970. Contract AT(30-1)-1156. 28p. (CONF-700534-1). Dep. CFSTI.

From American Institute of Mechanical Engineering Uranium Symposium, Socorro, New Mexico.

The high-productivity flowsheet employed for the purification of domestic concentrates of uranium by the tributyl phosphate (TBP) liquid extraction process is described. Although the modified TBP system has a greater tolerance for the impurities in concentrates, some maximum impurity limits must be specified. The purification

capabilities of the modified system are discussed in terms of the impurities normally found in various types of concentrates. (auth)

46306 (NLCO–1069) AQUEOUS REMOVAL OF SODIUM BOND FROM UNIRRADIATED HALLAM FUEL ELEMENTS. Miller, G. P. (National Lead Co. of Ohio, Cincinnati). 14 May 1970. Contract AT(30-1)-1156. 10p. (CONF-700608-20). Dep. CFSTI.

From American Nuclear Society Meeting, Los Angeles, Calif.

More than 15 tons of uranium were recovered from unirradiated uranium carbide fuel elements. The 15-foot-long, stainless-steel-clad, sodium-bonded fuel elements were cut to 11⅝-inch lengths and submerged in water. The water reacted with the sodium, freeing the UC core. The cores were then converted to U_3O_8 in water, and the U_3O_8 was dissolved in nitric acid and processed through the regular refinery system for recovery of their uranium values. (auth)

46307 (ORNL–4548, pp 93-186) CHEMISTRY. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

Progress is reported on investigations of the chemistry of MSRE fuel salt and off-gas streams and the transport, distribution, and chemistry of fission products in these streams. Topics discussed include properties of the alkali fluoroborates; physical chemistry of molten salts; chemistry of molten salt reactor fuel reprocessing technology; and development and evaluation of analytical methods for molten salt reactors. (D.H.M.)

46308 (ORNL–4548, pp 277-333) MOLTEN-SALT PROCESSING AND PREPARATION. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

Progress is reported on molten salt processing and preparation. Topics discussed include: flow sheet analysis; measurements of distribution coefficients in molten salt–metal systems; engineering development of process operations; distillation of MSRE fuel carrier salt; systems calculations; continuous salt purification system; and design and preparation of ^{239}PuF capsules for small refueling additions to the MSRE. (D.H.M.)

46309 (STI/DOC–10/106) VOLUME REDUCTION OF LOW-ACTIVITY SOLID WASTES. Pradel, J.; Parsons, P. J.; Malasek, E. (International Atomic Energy Agency, Vienna (Austria)). 1970. 44p. IAEA $2.00.

Methods for the reduction of the volume of low-activity solid wastes are discussed, including mechanical methods of volume reduction, incineration, lead melting, melting of ferrous materials and special steels, acid reduction, and mummification of animal carcasses. A comparison is made of the methods and some practical advice as to the most suitable choices for dealing with various special problems is given. (D.H.M.)

46310 METHOD FOR THE RECOVERY OF NUCLEAR FUEL FROM NUCLEAR FUEL OR BREEDER ELEMENTS. (to Kernforschungsanlage Juelich GmbH). British Patent 1,202,074. 12 Aug 1970. Priority date 12 Dec 1966, Germany.

Nuclear fuels can be recovered from partially spent or breeder elements having an envelope of carbides, graphite, or metal by treatment with molten commercial iron, pig iron, or scrap steel. In the molten phase, the soluble fuel or breeder material is separated by selective oxidation of the bath by the addition of iron oxides or other oxidizing agents, such as air, oxygen, CO_2, or steam, with the formation of a solid or liquid slag. The method is also applicable to coated fuel or breeder material particles. (B.L.M.)

46311 ROLE OF INDUSTRY IN THE FUEL CYCLE IN THE USA. Casa, Anna Francesca; Perilli, Maria Luisa. Com. Naz. Energ. Nucl., Notiz.; 16: No. 4, 62-72(Apr 1970) (In Italian).

A discussion of the main activities of the US industry in the field of the fuel cycle: uranium ore exploration and reserves; uranium ore processing facilities; information on some uranium producers; sale of concentrates; conversion of uranium into UF_6; fuel fabrication; and fuel reprocessing is presented. (auth)

46312 EXTRACTION OF ZIRCONIUM AND HAFNIUM WITH TRIFLUOROMETHYL-SUBSTITUTED HYDROXAMIC ACIDS. Le Roux, H. J.; Fouche, K. F. (Univ. of Orange Free State, Bloemfontein, South Africa). J. Inorg. Nucl. Chem.; 32: 3059-63(Sep 1970).

The compounds o-, p-, and m-trifluoromethyl-N-benzoyl-N-phenylhydroxylamine and 3-trifluoromethyl-5-nitro-N-benzoyl-N-phenylhydroxylamine were synthesized and the solvent extraction of zirconium and hafnium with these chelating agents was investigated. Stability constants were calculated from the experimental results. (auth) (UK)

46313 ANION EXCHANGE BEHAVIOUR OF ALKALINE EARTH ELEMENTS IN DIOXANE–WATER–HYDROCHLORIC ACID AND DIOXANE–WATER–PERCHLORIC ACID MEDIA. Czosnowska, W. (International Atomic Energy Agency, Seibersdorf, Austria). Radiochem. Radioanal. Lett.; 4: 293-300(31 Aug 1970).

The uptake of strontium and calcium by the strongly basic anion exchange resin Dowex-1 from dioxane–water–hydrochloric acid and from dioxane–water–perchloric acid media was measured. In contrast to the high uptake from media containing HCl only, a very low uptake was observed for systems containing $HClO_4$. A correlation between the alkaline earth uptake and the uptake of water and acid was found. (auth)

46314 PURIFICATION OF CYCLOTRON-PRODUCED ^{195}Au. Neirinckx, R. D. (National Physical Research Lab., Pretoria). Radiochem. Radioanal. Lett.; 4: 247-50(31 Aug 1970).

A method is described for the purification of cyclotron-produced, high specific activity ^{195}Au from a proton-irradiated platinum target. It is based on the extraction of gold by ethyl acetate from a 10% hydrochloric acid solution. More than 98% of the gold can be separated from 99.99% of the platinum. (auth)

46315 RADIOCHEMICAL SEPARATION WITH THE HELP OF THE RING OVEN METHOD. VI. SELECTIVE SEPARATION OF SINGLE NUCLIDES FROM A MIXTURE OF LONG-LIVED URANIUM FISSION PRODUCTS. Klockow, D.; Abe, S. (Univ., Freiburg i. B.). Radiochem. Radioanal. Lett.; 4: 237-45(31 Aug 1970). (In German).

Simple ring-oven separation steps are described for the selective isolation of ^{137}Cs, $^{95}Zr/^{95}Nb$, ^{106}Ru, and $^{90}Y + ^{144}Ce/^{144}Pr$ from a mixture containing long-lived fission products. (auth)

46316 PREPARATIVE SEPARATION OF LANTHANIDES BY COUNTERCURRENT ELECTROLYSIS. Bilal, B. A.; Metscher, K. (Hahn-Meitner Inst., Berlin). J. Inorg. Nucl. Chem.; 32: 2789-90(Aug 1970). (In German).

Gram quantities of La, Ce, Pr, Nd, and Sm were separated to impurity levels of <1 ppM by countercurrent electrolysis in aqueous acetate solution. (UK)

46317 URANYL ION SORPTION ON EDTA-FORMS OF ANION EXCHANGERS. Eristavi, D. I.; Brouchek, F. I.; Berishvili, L. A. (Georgian Polytechnic Inst., Tbilisi, USSR). Chem. Zvesti; 23: 759-64(1969). (In Russian).

The sorption of uranyl ions on the EDTA-forms of anion exchangers in solutions at pH 3 was confirmed by x-ray analysis. On the basis of infrared spectra, the probable schemes were proposed for the formation of EDTA uranyl complexes in the phase of EDTA anion exchangers at pH 3 which corresponded to the formulas $[UO_2(H_2Y)_2]^{2-}$ and $[UO_2Y]^{2-}$. The values of the dynamic sorption capacities of the EDTA-forms of the anion exchangers AN-2Fg, AV-16 and AV-17 were determined for uranium over the concentration range of 0.014 to 0.114 mg equiv ml^{-1} by the method involving the construction of output curves of sorption under various hydrodynamic conditions. Besides, the optimum hydrodynamic conditions for the work of the sorption columns were found out. The optimum value of the specific filtration load was 16.66 h^{-1} for a 9-cm layer of ion exchanger. The investigated anion exchangers may be ranged according to their prospective utilization in the analytical chemistry of uranium as follows: AN–2Fg < AV-17 < AV-16. (auth)

46318 TREATMENT AND DISPOSAL OF RADIOACTIVE WASTE. Graf, P.; Zuend, H. (Motor-Columbus AG, Baden, Switzerland). Neue Tech., B; 11: 112-27(1969). (In German).

The crucial problems of waste management in finding appropriate methods of waste treatment and storage that ensure the safety of the population from ionizing radiation but are reasonably economical are discussed. The most important proven processes are reviewed and the possibilities of applying them in the peculiar situation of Switzerland are discussed. Although waste treatment and storage involves important problems, a cost estimate shows that the addition to production costs of electricity is a few percent. (auth)

46319 EKSTRAKTSIYA AMINAMI. (Extraction by Amines). Shmidt, V. S. Moscow; Atomizdat (1970). 312p.

Physicochemical processes of metal salt and acid extraction by amines and quaternary ammonium salts are described. A review is given of various extracting systems used in hydrometallurgy, chemical technology, fuel reprocessing, radiochemistry, uranium refining, and radioactive waste processing. (R.V.J.)

46320 SPONTANEOUS DEPOSITION OF ^{210}Po FROM CHLORIDE SOLUTION. Chong, C. H. H.; Prisc, M. D. (Monsanto Research Corp., Miamisburg, Ohio). Nucl. Appl. Technol.; 9: 667-72(Nov 1970).

Removal of polonium by spontaneous deposition onto bismuth powder (referred to as scrubbing) following dissolution of irradiated bismuth and denitration is the step normally employed in the processing scheme as a means of concentration from relatively dilute solutions. This separation and concentration, and to some extent purification, is achieved by allowing the solution, in high chloride-ion concentration, to flow through a fixed bed of bismuth powder. A variation of this process was investigated utilizing the agitation of the bismuth powder with an inert gas to effect a more intimate contact with the polonium. The effects of bismuth particle size (surface area), quantity of powder used, rate of polonium deposition, initial polonium concentration, and the manner and extent of agitation were studied. The results indicated quantitative yields were realized by this modified process. (auth)

46321 DISTRIBUTION EQUILIBRIA INVOLVING PLUTONIUM(III) BETWEEN ORGANIC TRILAURYLAMMONIUM NITRATE SOLUTIONS AND AQUEOUS NITRIC ACID SOLUTIONS. Chiarizia, R.; Danesi, P. R.; Scibona, G. (CNEN, Rome). J. Inorg. Nucl. Chem.; 32: 3073-9(Sep 1970).

Hitherto in the solvent extraction of Pu by organic solutions of long chain tertiary alkylammonium salts from aqueous nitric acid solutions containing reducing agents, the low value of the distribution coefficient has been attributed to Pu(III) extraction. Now, a different point of view has been adopted, and it is assumed that the Pu present in the organic phase is in the four-valent state. The small D values are explained in relation to all the equilibria that can occur. An expression for D taking care of the oxidation–reduction equilibria is derived. Comparisons between experimental results (in presence of ferrous sulphamate as reducing agent) and calculated D values, and also spectrophotometric measurements, support the suggested mechanism. (UK)

46322 SOLVENT EXTRACTION OF METALS. De, A. K.; Khopkar, S. M.; Chalmers, R. A. London; Van Nostrand Reinhold Company (1970). 269p. 120s.

The general principles of solvent extraction are discussed, together with the use of β-diketones, 8-hydroxyquinoline and its derivatives, oximes and dioximes, cupferron and analogous compounds, nitrosophenols and pyridylazonaphthol, dithizone, dithiocarbamates, xanthates and dithiol, organophosphorus acids, esters and oxides, high-molecular-weight amines, and molecular and ion association compounds. Selective extraction procedures are included for Be, Sr, Po, Sc, V, Y, Zr, Nb, Mo, Tc, Ru, Hf, W, Ce, Ac, Th, U, Np, Pu, and Am. (UK)

46323 COMPARISON OF METHYL ACETYLENE AND HYDROGEN SULFIDE EXCHANGE WITH WATER FOR CONCENTRATING DEUTERIUM IN A DUAL TEMPERATURE SYSTEM. Goldfrank, Jack Charles. New York; Columbia Univ. (1969). 305p.

Thesis.

Both the hydrogen sulfide–water and the methyl acetylene–water isotope exchange reactions were investigated in the same dual temperature system operating at the same temperatures. The deuterium enrichment obtained using the methyl acetylene–water isotope exchange reaction (19.1‰) is much less than the enrichment obtained by using the hydrogen sulfide–water isotope exchange reaction (128.7‰). Some of the factors contributing to this large difference in deuterium enrichment are: (1) The physical and thermodynamic properties of the hydrogen sulfide–water isotope exchange reaction are more favorable for extracting deuterium in a dual temperature system than in the other system. (2) The rate of the hydrogen sulfide–water isotope exchange reaction is more rapid than the rate of the methyl acetylene–water isotope exchange reaction. The permissible operating limits, the optimum liquid-to-gas flow, L/G, and the number of theoretical plates which is related to the H.E.T.P. in the dual temperature system were calculated and measured. For the methyl acetylene–water system a wide, near-optimum operating range ($0.65 \leq L/G \leq 1.15$) was predicted, and the wide optimum operating range of $0.70 \leq L/G \leq 1.20$ was observed. Similarly, a relatively narrow operating range for the hydrogen sulfide–water system was predicted ($L/G = 0.47$) and confirmed ($L/G = 0.48$). A transient model was developed for both of the isotope exchange reactions which were studied. This model was capable of predicting the deuterium concentration on any tray in the dual temperature system as a function of time. The atom percent deuterium in the product at steady state which was predicted from this model was 4.6% too high for the methyl acetylene isotope exchange reaction, and 2.6% too low for the deuterium exchange between hydrogen sulfide and water. Three independent sets of experiments were performed in the methyl acetylene–water system in order to measure the equilibrium constants at 25° and 80°C: 1) static equilibration based on a liquid phase analysis, 2) flow equilibration based on a liquid phase analysis, 3) flow equilibration based on a gas phase analysis. The results of these experiments differ significantly from some previously reported experimental and theoretical values. It can be concluded from this study that the methyl acetylene–water isotope exchange reaction in a dual temperature system is not an attractive system for enriching heavy water. (Diss. Abstr., B) (TSS)

46324 EXTRACTION OF URANYL NITRATE BY DI-n-HEPTYL SULFOXIDE (DHpSO). MECHANISM OF THE EXTRACTION. Laurence, G.; Chaieb, M. T. (Ecole Normale Superieure de Chimie, Paris). Bull. Soc. Chim. Fr.; No. 7, 2481-5(Jul 1970). (In French).

Diheptyl sulfoxide (DHpSO) diluted in carbon tetrachloride can extract uranyl nitrate from aqueous nitrate solutions. The extraction is due to the formation of a complex $UO_2(NO_3)_2 \cdot 2DHpSO$ in an organic phase. This complex formation is observed by infrared spectrophotometry. A simple equilibrium is proposed to investigate the mechanism in the case of an extraction in acid medium. It was applied to the calculation of the variation of the partition ratio as a function of the starting sulfoxide concentration. (auth) (France)

46325 EFFECT OF DILUENT OF THE TRI-n-HEXYLAMINE NITRATE IN MOBILE PHASE ON R_M VALUES OF URANIUM, THORIUM, BISMUTH, AND MERCURY ON FILTER PAPER IMPREGNATED WITH NITRIC ACID OR LITHIUM NITRATE SOLUTIONS. Flieger, Anna; Przeszlakowski, Stanislaw; Soczewinski Edward (Dept. of Inorganic and Analytical Chemistry, Lublin). Chem. Anal. (Warsaw); 15: 545-52(1970) (In Polish)

Chromatographic behavior of uranium(VI), thorium, bismuth, and mercury(II) ions on filter paper impregnated with aqueous HNO_3 or $LiNO_3$ solutions of various concentration was investigated. Solutions, 0.1 M, of trihexylamine (THA) nitrate in various diluents as well as isobutyl methyl ketone and butyl acetate (without amine) were used as a mobile phase. The plots of R_M values for bismuth and mercury(II) vs nitric acid concentration showed maxima in the range of 1 to 2 M HNO_3. In the case of papers impregnated with $LiNO_3$, R_M values for these metals increased with the increase of NO_3^- ion concentration in the stationary phase. The smallest R_M values were obtained using the solvents belonging to class "A" (according to Pimentel and McClellan's classification) as diluents of THA nitrate. R_M values decreased in the series of diluents: 1, 2-dichloroethane > ~1,1-dichloroethane > trichloroethylene > $CHCl_3$. When solvents of classes "B" and "N" respectively were used as diluents of THA nitrate, R_M values depended upon the metal and to a lesser extent upon the composition of stationary phase (HNO_3 or $LiNO_3$). When using 0.1 M THA nitrate solutions in benzene or CCl_4, thorium was better extracted than uranium while the reverse was true when isobutyl methyl ketone, butyl acetate, and nitrobenzene were used as diluents. Highest separation factors of uranium and thorium were obtained for 0.1 M THA solutions in isobutyl methyl ketone. (auth)

46326 IMPROVEMENTS IN OR RELATING TO LIQUID–LIQUID SEPARATION. Trowell, Frank; Baker, Carroll William (to United Kingdom Atomic Energy Authority). British Patent 1,201,311. 5 Aug 1970. Filed 14 Apr 1967.

Solvent extraction apparatus for separating immiscible liquid–liquid phases having different electric conductivities and densities is described. The apparatus is a vessel with a lower portion of reduced cross section, with an outlet duct extending from this lower portion at or near the bottom. The duct is provided with a valve for liquid flow control, means for sensing the electric conductivity of a liquid phase at the bottom of the vessel, and control means to close the valve as the interphase between the two phases falls past the sensing means. The control means is operable by the sensing means detecting a change in conductivity. The lower portion of the vessel may be of electrically insulating material, and the sensing means may comprise a pair of electrically conducting probes. The control means may be preset to cause the valve to close either when passage of the interphase past the sensing means causes the current to increase or decrease as desired. The vessel is provided with inlet means at its upper end for introducing reactants, stirring means, and outlet means for withdrawing the less dense phase. (UK)

46327 CHEMISTRY OF PLUTONIUM. Cleveland, J. M. New York; Gordon and Breach, Science Publishers, Inc. (1970). 672p. $39.50. (TID-25526).

Twenty chapters are included. The topics covered are: the Pu atom; oxidation states in solution; oxidation-reduction reactions; hydrolysis; complexes; ion exchange; solvent extraction; nonaqueous and molten salt chemistry; oxides, hydroxides, and peroxide; halides and halates; hydrides and deuteride; carbides and silicides; carbonates and oxalates; nitride, phosphide, arsenide, and antimonide; sulfides, selenides, and telluride; sulfates, nitrates, phosphates, and arsenates; other compounds; separation

from irradiated reactor fuel; conversion processes; and recovery and waste disposal. Separate author and subject indexes are included. (P.C.H.)

46328 METHOD OF DECANNING NUCLEAR FUEL ELEMENTS HAVING A CAN OF STAINLESS STEEL, NICKEL–CHROMIUM–IRON ALLOY OR NICKEL–CHROMIUM ALLOY. Wurm, Joseph Gerard; Payrissat, Maurice (to EURATOM). British Patent 1,203,819. 3 Sep 1970. Priority date 31 Oct 1967, Belgium.

A method is described for decanning a nuclear fuel element having a can of stainless steel, Ni–Cr alloy, or Ni–Cr–Fe alloy by dissolving the can in a metallic solvent composed of 95 to 65 wt % Sb and 5 to 35 wt % Cu at temperatures from 700 to 1000°C. The molten metallic solvent is covered with a mixture of salts containing at least one halide whose free energy of formation is much less than that of NaCl or CsCl. An apparatus for the dissolution is described. (B.L.M.)

46329 STUDIES ON REMOVAL OF RADIOIODINE BY ACTIVATED CARBON. III. REMOVAL EFFICIENCY OF FULL-SIZE CHARCOAL FILTER UNIT FOR IODINE. Murata, Toshifumi; Kamiya, Kunio (Hitachi Ltd., Tokyo). Nippon Genshiryoku Gakkaishi; 12: 436–41(1970). (In Japanese).

To evaluate the performance of a large charcoal filter, a full sized charcoal filter unit (600 mm × 600 mm) was constructed, and the removal efficiency of each filter for I was determined under various conditions using radioactive I as tracer. The principal variables applied in this test were selected so as to be analogous with those of the previous experiment. The results of the test indicate no significant variation in the removal efficiency of the charcoal filter due to increased filter size. And it was found that in the range covered by the present tests the efficiency for I plus methyl iodide determined by the present experiment agreed with the value determined by empirical formula. (auth)

46330 NON-IDEAL BEHAVIOR IN COUNTERCURRENT ELECTROMIGRATION OF BINARY LiCl + KCl MIXTURE. Kanno, Hitoshi (Tokyo Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 428–30(Aug 1970).

Countercurrent electromigration studies were carried out in the molten salt system LiCl–KCl using a heated cell with a 15-cm-long separation column. The column was packed with quartz powder, and the packed column was inserted into the melt and left until the melt penetrated through the quartz powder to reach the anode. After electromigration, the column was divided into several sections, and the content of cations determined. Heavy isotopes appeared to be enriched toward the upper part of the separation column; however, there was considerable enrichment of the light isotope ^6Li in the lower part of the column. Separation factors for the Li isotopes in two experiments were 1.04 and 1.14 at the mouth of the separation column. (B.L.M.)

46331 COLLECTION OF URANIUM FROM SEA WATER BY GALENA. Koyanaka, Yoshio (Kyoto Univ., Osaka). J. Nucl. Sci. Technol. (Tokyo); 7: 426–7(Aug 1970).

Uranium was collected from samples of both natural and artificially prepared seawater by sorption on galena columns. The U was eluted from the columns with 10 % Na_2CO_3. The eluted U was treated with HNO_3 and then extracted with TBP–isooctane solution for determination by uv spectrophotometry to 250 mμ. The galena particles were regenerated by washing with a dilute HCl solution of pH 5.0. (B.L.M.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 46189, 46370, and 46532.

46332 (BNWL-1429) AN IRREVERSIBLE THERMODYNAMIC APPROACH TO SIMULTANEOUS MOVEMENT OF WATER, HEAT, AND SALT THROUGH UNSATURATED SOILS. Enfield, C. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 42p. Dep. CFSTI.

Literature was reviewed to obtain the basis for the simultaneous flow of water, heat, and salt through unsaturated soils. Flow theories were developed from the general theory of water flow in saturated soil under isothermal conditions to the analysis of simultaneous solution flow caused by two driving forces, such as water and heat, using irreversible thermodynamics. Based on this review, conclusions were made that the theory of irreversible thermodynamics is the most applicable approach for modeling when both liquid and vapor transport are to be considered. (auth)

46333 (BNWL-SA-3193) IMPROVED METHODS FOR PLANNING OF THERMAL DISCHARGES BEFORE SITE ACQUISITION WITH A SPECIFIC CASE EXAMPLE ON THE COLUMBIA RIVER. Jaske, R. T.; Templeton, W. L.; Eliason, J. R.; Sonnichsen, J. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). [1970]. 32p. (CONF-700810-21; SM-146/46). Dep. CFSTI.

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The waste heat from the operation of Rankine cycle generating plants must in some way be dissipated to the environment. Freshwater streams and estuaries remain as a feasible location for such plants. However, because of the size of the thermal releases it is necessary to determine the capacity of these areas to receive heat within water quality standards without adverse effect on aquatic organisms outside control zones. In the United States of America, temperature differences as little as 0.82°C are seriously proposed as limits in estuarine circumstances. Means to evaluate temperatures with such precision on an integrated sample basis do not presently exist or are not recognized as standard methods. A series of new experimental and analytical techniques are under development in order to meet the goals of accuracy in physical prediction required. Commencing in 1963 and continuing to the present, a highly flexible computation system COL HEAT has been developed and extended for use in estimating interrelated physical effects in estuaries and rivers with highly transient flow conditions. This computer simulation model permits detailed planning of discharges in advance for single and multiple plant locations of overlapping complexity limited only by the accuracy of the input data base. To gain fuller understanding of the situation close to the point of discharge, extensive research was conducted using a variety of physical measurement techniques. The most promising has been the use of remote imagery with airborne detectors. The system has produced state-of-the-art capabilities which permit detailed, real time measurements of two-dimensional concentration gradients in mixing areas. Computer generated illustrations of the concentration isopleths are included in the presentation; currently threshold limits of detectability of dye using this method are less than 0.05 ppb, far below visible limits. A special model which relates the hydraulic effects at the point of discharge to thermal tolerances in fish has been developed. This model permits numerical estimation of the probability and extent of thermal damage to migrant fish under a variety of biological threshold detection limits. The application of these methods to a practical case problem was accomplished in work supporting a licence application for a direct cooled reactor plant at Columbia River Mile 78 (Kalama, Washington). The predictive needs at this site are very complex because of flow reversals. Based on extensive field data for determining modelling coefficients applicable to the river reach, and prediction of appropriate concentration for the mixed effluent, siting feasibility was recommended. In conclusion, the improved technological insight required under newly expected siting criteria in all countries demands new and improved methods for doing work. Usefulness of these new methods is not confined to the nuclear industry. (auth)

46334 (NYO-3953-2) APPLICATION OF NUCLEAR TECHNOLOGY TO ART IDENTIFICATION PROBLEMS. Annual Report No. 2. Keisch, Bernard (Mellon Inst., Pittsburgh, Pa.). Feb 1970. Contract AT(30-1)-3953. 51p. Dep. CFSTI.

A workable scheme for the separation of lead white from extraneous material in paintings is described for use in analysis by neutron activation (NAA). Data are presented on the effects on NAA of possible contaminants. Data are also presented for NAA of natural and synthetic ultramarine blue and of Van Dyke brown which indicate possible uses for the method. Results obtained for the analysis of lead-bearing metals for natural alpha radioactivity show that "modern" material may be discerned but that older materials usually yield ambiguous results. The construction of a low-level, small-sample carbon-14 counter is described. This counter is to be used to detect recent man-made additions of carbon-14 to certain artists' materials, especially linseed oil. (auth)

46335 (UCRL-Trans-10484) PATTERNS OF HELIUM DISTRIBUTION IN THE GROUND WATERS OF THE RUSSIAN PLATEAU. Voronov, A. N. Translated by B. Thayne for Univ. of California, Lawrence Radiation Lab., Livermore, from Izv. Akad. Nauk SSSR, Ser. Geol.; 32: No. 12, 127-32(1967). 12p. Dep. CFSTI.

A general description of helium distribution patterns in groundwaters of the Russian Plateau is given based on a statistical study of data from 700 groundwater gas analyses. It is concluded that the basic factors which determine the concentration and pressure of the helium in the waters are the helium-producing capacity and age of the rocks, the thickness of the sedimentary stratum and position of the deposits in it, and the character and intensity of the groundwater movement. (L.C.L.)

46336 (USGS-474-31) HYDRAULIC TESTING OF WELL HTH-4 IN CENTRAL NEVADA. Central Nevada-34. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT-(29-2)-474. 21p. Dep. CFSTI.

An analysis of data obtained during hydraulic tests in hydrologic test hole HTH-4, Little Smoky Valley, Nevada is presented. The analysis is focused primarily on determining variations in hydraulic potential in the vertical section and transmissivity, hydraulic conductivity, storage coefficient, and velocity of ground-water movement in selected intervals of anticipated high permeability. Hole HTH-4 penetrated alluvium, rhyolite, and welded tuff. The composite water level, measured in the perforated 5½-inch casing, was 157.5 m below land-surface datum. In the tested intervals from which the data were adequate for analysis, transmissivity ranged from an estimated 7.3×10^{-2} to 7.3 m^2/day per m; hydraulic conductivity ranged from an estimated 8.0×10^{-4} to 8.0×10^{-1} m^2/day per m^2; and velocity ranged from an estimated 3.2×10^{-4} to 1.9×10^{-2} m/day. However, all of these values probably are low. Because of adverse conditions, the hole was drilled with mud and the hydraulic tests were made through perforated, cemented casing. During the cementing process, drilling mud and cement were forced into the water-bearing fractures and effectively sealed them from the borehole. (auth)

46337 (USGS-474-39) HYDRAULIC TESTING OF WELL HTH-5 IN CENTRAL NEVADA. Central Nevada-37. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT-(29-2)-474. 15p. Dep. CFSTI.

An analysis of data obtained during hydraulic tests in hydrologic test hole HTH-5, Hot Creek Valley, Nevada is presented. Data collection was focused primarily on determining variations in hydraulic potential in the vertical section and permeability of the most transmissive intervals. Hole HTH-5 penetrated alluvium, tuffaceous sandstone and siltstone, and welded tuff with thin intervals of bedded tuff. The composite water level with the hole open from 635.2 to 1,830.8 m and with the casing perforated in two intervals from 173.7 to 179.8 m and from 536.4 to 551.7 m was 35.1 m below land-surface datum. In the tested intervals from which the data were adequate for analysis, static water levels ranged from 38.42 m below land-surface datum to 136.5 m above land-surface datum and relative specific capacities ranged from an estimated 6×10^{-5} to 1.8×10^{-1} cubic meters per day per meter of drawdown. (auth)

46338 (USGS-474-70) REPORT OF EXPLORATION PROGRESS, PAHUTE MESA, JANUARY 31, 1968-OCTOBER 1, 1969. Orkild, Paul P.; Jenkins, Evan C. (Geological Survey, Denver, Colo.). 1970. Contract AT(29-2)-474. 79p. Dep. CFSTI.

Preliminary data for drill holes and emplacement holes in the Pahute Mesa are tabulated and include location coordinates, surface elevation, depth, and lithographic information on rock type and stratification. (L.C.L.)

46339 (USGS-474-78) HYDRAULIC TESTING AND SAMPLING OF HOLE Ue-2, IN CENTRAL NEVADA. Central Nevada-

8. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT(29-2)-474. 23p. Dep. CFSTI.

Hydraulic testing and sampling of hole Ue-2 began on January 16, 1967, and ended on January 22, 1967. Seven depth intervals, beginning at 434 feet and extending to total depth, were tested and sampled. Injection tests were run on all depth intervals; recovery tests were run on intervals 2 through 7. In only one interval (zone 4) was the recovery-test curve suitable for determining relative specific capacity. In that zone, relative specific capacity calculated from recovery data was much less than that calculated from injection data. The composite hydrostatic head before and after injection and recovery tests was 579.6 feet below lsd (land-surface datum). In all zones where the static water level was measured after injection and then after swabbing the static water level changed after swabbing. (auth)

46340 (USGS-474-79) HYDRAULIC TESTING AND SAMPLING OF HOLE Ue-3, IN CENTRAL NEVADA. Central Nevada-9. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT(29-2)-474. 21p. Dep. CFSTI.

Hydraulic testing and sampling of hole Ue-3 began on February 11, 1967, and ended on February 19, 1967. Depth intervals tested were: zone 1, 1,492 feet to total depth; zone 2, 1,310 to 1,488 feet; zone 3, 1,004 to 1,182 feet; zone 4, 865 to 1,043 feet; zone 5, 610 to 788; and zone 6, surface to 400 feet. Injection and recovery tests were successfully run on zones 1, 2, and 6; in general in each zone the relative specific capacity calculated from the recovery test data exceeded that calculated from the injection test data. Test data indicate that permeability of zones 3, 4 and 5 is high whereas permeability of zone 1 is low. Mud in the borehole made a pretest determination of the composite hydrostatic head impossible. After testing, the static water level was 238.13 feet below lsd (land-surface datum). (auth)

46341 (USGS-474-80) HYDRAULIC TESTING OF WELLS IN CENTRAL NEVADA. Central Nevada-20. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT(29-2)-474. 110p. Dep. CFSTI.

Basic data obtained during hydraulic tests in six exploratory holes before February 1968 are presented. Hole UCe-11 penetrated alluvium and welded tuff. A short hydraulic test run on this hole indicated that the welded tuff had a low permeability. The composite water level was about 360 feet below land-surface datum. Hole UCe-16 penetrated alluvium, welded tuff, bedded tuff, and rhyolite. After completion, the well was flowing. Relative specific capacities of the tested zones ranged from an estimated 0.0003 gallon per minute per foot of drawdown to high, and static water levels of the tested zones ranged from about 100 feet below land-surface datum to 19.29 feet above land-surface datum. Hole UCe-17 penetrated, alluvium, tuff, and tuffaceous sediments. The composite water level was 528 feet below land-surface datum; relative specific capacities of the tested zones ranged from an estimated 0.0003 gallon per minute per foot of drawdown to high; and static water levels of the tested zones ranged from about 575 to an estimated 1,150 feet below land-surface datum. Hole UCe-18 penetrated alluvium, lake beds, rhyolite, and bedded tuff. The composite water level was 196 feet below land-surface datum; relative specific capacities of the tested zones ranged from low to high; and static water levels of the tested zones ranged from about 190 to 330 feet below land-surface datum. Hole HTH-1 penetrated alluvium, welded tuff, and tuffaceous sediments. The composite water level was 553 feet below land-surface datum; relative specific capacities of the tested zones ranged from an estimated 0.0003 gallon per minute per foot of drawdown to very high; and static water levels of the tested zones ranged from 547 to 558 feet below land-surface datum. Results of a pumping test indicated that the velocity of ground-water movement in two zones (700 to 850 feet and 950 to 1,150 feet) was about 0.5 foot per day. Hole UCe-20 penetrated alluvium, welded tuff, and tuffaceous conglomerate. The composite water level was 215 feet below land-surface datum; relative specific capacities of the tested zones ranged from 0.000015 gallon per minute per foot of drawdown to very high; and static water levels of the tested zones ranged from 215 to about 340 feet below land-surface datum. (auth)

46342 (USGS-474-81) HYDRAULIC TESTING OF WELL HTH-21-1 IN CENTRAL NEVADA. Central Nevada-22. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT(29-2)-474. 34p. Dep. CFSTI.

An analysis of data obtained during hydraulic tests in hydrologic test hole HTH-21-1, Little Smoky Valley, Nevada is presented. The analysis is focused primarily on determining transmissivity of selected intervals within the zone of interest. Further analysis is concerned with determining variations in hydraulic potential in the vertical section and transmissivity, hydraulic conductivity, storage coefficient, and velocity of ground-water movement in selected intervals of the entire hole. Hole HTH-21-1 penetrated alluvium, welded tuff, and tuffaceous sediments. The composite water level was 151.56 m below land-surface datum. In the tested intervals from which the data were adequate for analysis, transmissivity ranged from an estimated 1.4×10^{-4} to 23.1 m^3/day per m; hydraulic conductivity ranged from an estimated 1.5×10^{-7} to 1.94 m^3/day per m^2; and velocity ranged from an estimated 4.5×10^{-9} to 0.058 m/day. However, velocities of ground-water movement through some intervals might be significantly greater, depending on the thicknesses of the water-contributing fracture systems. (auth)

46343 (USGS-474-82) ANALYSIS OF HYDRAULIC TESTS IN HOT CREEK VALLEY, NEVADA. Central Nevada-23. Dinwiddie, George A. (Geological Survey, Denver, Colo.). Jun 1970. Contract AT(29-2)-474. 63p. Dep. CFSTI.

An analysis of data obtained during hydraulic tests in exploratory holes, Hot Creek Valley, Nevada is presented. The analysis is focused on determining variations in hydrostatic head in the vertical section; transmissivity, hydraulic conductivity, storage coefficients, and velocity of ground-water movement in selected intervals; and inflow to a theoretical chamber. Hole UCe-17 penetrated alluvium, welded tuff, zeolitized bedded tuff, and tuffaceous sediments. The composite water level was 161.0 meters below land-surface datum. In the tested intervals from which the data were adequate for analysis, transmissivity ranged from 8.47×10^{-4} to an estimated 8.76 m^3/day per m; hydraulic conductivity ranged from 1.39×10^{-5} to an estimated 1.44×10^{-1} m^3/day per m^2; storage coefficients ranged from 6.26×10^{-7} to 5.65×10^{-3}; and velocity ranged from 9.27×10^{-7} to an estimated 1.44×10^{-2} m/day. Hole UCe-18 penetrated alluvium, lake beds and gypsum, rhyolite, and bedded tuff. The composite water level was 59.8 meters below land-surface datum. Only the data from the interval 1,237.8 to 1,277.4 meters were adequate for analysis; transmissivity was 4×10^{-3} m^3/day per m; hydraulic conductivity was 1×10^{-4} m^3/day per m^2; storage coefficient was 6.1×10^{-7}; and velocity was 5×10^{-6} m/day. Specific capacity after 9 hours of pumping was 55.5 m^3/day per m of drawdown. Hole UCe-20 penetrated alluvium, welded tuff, and tuffaceous conglomerate. The composite water level was 65.5 meters below land-surface datum. In the interval 1,652.4 to 1,670.7 meters below land surface the static water level was also 65.5 meters below land surface, and the hydraulic potential decreased both above and below this zone. In the tested intervals from which the data were adequate for analysis, transmissivity ranged from 2.48×10^{-4} to 43.8 m^3/day per m; hydraulic conductivity ranged from 1.18×10^{-6} to 2.05 m^3/day per m^2; storage coefficients ranged from 4.67×10^{-7} to 6.10×10^{-3}; and velocity ranged from 5.9×10^{-7} to 1×10^{-1} m/day. Inflow to a theoretical cylindrical chamber 3.66 meters in diameter and at a depth of from 1,524.4 to 1,533.5 meters below land surface in UCe-20 was computed using a leaky artesian, constant-drawdown formula. Because of many variables and unique conditions, the computation can be considered only as an approximation. The inflow to the theoretical chamber probably would be about 14 cubic meters per day after an elapsed inflow time of about 70 days. Hole HTH-1 penetrated alluvium, welded tuff, and tuffaceous sediments. The composite water level was 168.6 meters below land-surface datum. In the tested intervals from which the data were adequate for analysis, transmissivity ranged from 1.9×10^{-3} to an estimated 16.4 m^3/day per m; hydraulic conductivity ranged from 6.2×10^{-5} to an estimated 3.6×10^{-1} m^3/day per m^2; storage coefficients ranged from 6.1×10^{-7} to 6.1×10^{-3}; and velocity ranged from 1.2×10^{-5} to an estimated 7.2×10^{-2} m/day. Specific capacity after about 7 days of pumping was about 121 m^3/day per m of drawdown. (auth)

46344 GEOLOGY AND URANIUM ORE DEPOSITS IN THE CRETACEOUS KWANMON GROUP. Okuno, Takaharu (Power Reactor and Nuclear Fuel Development Corp., Tokyo). Kozan Chishitsu; 20: No. 2, 125-31(May 1970). (In Japanese).

Since the first discovery of uranium mineralization in the Mesozoic lacustrine Kwanmon group in 1966, many indications of uranium deposits were found in the province of West Chugoku and North Kyushu. The deposits in the Toyota district, Yamaguchi Prefecture are discussed as a typical example of them. The deposits were classified into four types by their modes of occurrence, namely, the dike-type, the fault fracture-type, the sandstone-type, and the carbonaceous material-type. The following were revealed after the geological investigation: the dike-type and fault fracture-type deposits were distributed in a straight line which ran parallel to the Nagato Tectonic Line of NE-SW trend; most sandstone-type deposits occurred within a restricted stratigraphical horizon; the grade of radioactive disequilibrium was closely related with the modes occurrence of the ore; thuringite in dikes and sandstones played an important role in concentrating the uranium; and urani-

nite, pitchblende, autunite, torbernite, uranophane, beta-uranophane, and phosphouranylite were identified in the enriched zones of the deposits. (auth) (Japan)

46345 GEOHYDROLOGIC INTERPRETATIONS OF A VOLCANIC ISLAND FROM ENVIRONMENTAL ISOTOPES. Davis, George H. (Geological Survey, Washington, D. C.); Lee, Chang Kun; Bradley, Edward; Payne, B. R. Water Resour. Res.; 6: 99-109(Feb 1970).

Isotopic analyses of ground waters collected from 1966 through 1968 on Cheju Island, Republic of Korea, have proved helpful in interpreting the general hydrologic relations and in developing a model of the ground water flow system in the permeable volcanic rocks of the island. Comparison of tritium and stable isotope ($D-^{18}O$) contents provided a basis for a model of the ground water flow regimes. Time variability of these isotopes determined by repeated samplings provided the basis for estimates of mean residence time of ground waters, ranging from about 2 to 9 years. Although the results are only approximate because simplified models were used, they can be of substantial assistance in planning further hydrologic investigations and appraising the feasibility of ground water development. (auth)

46346 DISTRIBUTION OF URANIUM IN URANIUM-SERIES DATED FOSSIL SHELLS AND BONES SHOWN BY FISSION TRACKS. Szabo, B. J.; Dooley, J. R. Jr.; Taylor, R. B.; Rosholt, J. N. U. S., Geol. Surv., Prof. Pap.; 700-B: 90-2 (1970).

Fission tracks show that uranium is dispersed throughout fossil shells and bones. However, a white layer of a shell may contain only half as much uranium as the darker organic-stained layer, and the surface layer of bone can be depleted in uranium. The distribution of uranium appears to be independent of age, uranium content, or departure from the ideal closed-system requirements. (auth)

46347 CALCULATED IN SITU BULK DENSITIES FROM SUBSURFACE GRAVITY OBSERVATIONS AND DENSITY LOGS, NEVADA TEST SITE AND HOT CREEK VALLEY, NYE COUNTY, NEVADA. Healey, D. L. U. S., Geol. Surv., Prof. Pap.; 700-B: 52-62(1970).

At the Nevada Test Site and Hot Creek Valley a borehole gravity meter was used to log four holes, and standard gravity meters were used to log five 48-inch-diameter holes and a vertical shaft. Three holes (Ue2y, test well B, and UCe-18) and the U5i shaft penetrated alluvium, and six holes penetrated Tertiary volcanic rocks on Pahute Mesa. The weighted average densities determined in the holes and shaft in alluvium are 1.94, 1.69, 2.22, and 2.05 g/cc, respectively; the density determined in five of the six holes in Tertiary volcanic rocks ranged from 1.98 to 2.06 g/cc. One hole (UE19n) penetrated a thick ash-flow tuff that averaged 1.51 g/cc. Density logs were taken in 10 additional holes. In Yucca Flat the mean density of more than 7,000 feet of alluvium is 2.01 g/cc, and in Hot Creek Valley the mean of more than 18,000 feet is 2.18 g/cc. (auth)

46348 RADIOACTIVE TRACER SURVEYING: A COMPREHENSIVE REPORT. Kelldorf, W. F. N. J. Petrol. Technol.; 22: 661-9(Jun 1970).

Radioactive tracer surveys are run in production and injection wells primarily to investigate dynamic conditions of fluid flow in and around a wellbore. The many factors involved in planning and obtaining accurate radioactive tracer surveys are discussed. The radioisotopes, the gamma detectors, tracer injector tools, and interpretation methods used in field applications are described. It is concluded that: radioactive tracer surveys provide an effective means for evaluating fluid distribution profiles in secondary recovery and pressure maintenance projects and for analyzing many producing-well problems; it is extremely important to select the proper radioisotope to match a particular well condition and the proper detector to trace the radioisotope (^{131}I and scintillation detectors are recommended for general use); tool design and interpretation method must be compatible; and that adequate field preparations must be made to insure successful radioisotope tracer surveys. (L.C.L.)

46349 NOTE OF THE LONG LIVED α AND β RADIOACTIVITY OF MINERAL WATERS IN SZCZAWNO. Rymaszewska, Maria; Zejmo, Irena (Univ., Warsaw). Acta Geophys. Pol.; 18: No. 1, 99-102(1970). (In Polish).

The α- and β-radioactivity of solid residues obtained by evaporation of several mineral waters from Szczawno has been investigated. The results are compared with the maximum permissible concentration of α- and β-emitters in drinking water. (auth)

46350 STUDIES IN GEOCHEMISTRY OF URANIUM AND PHOSPHORITES. Kolodny, Yehoshua. Los Angeles; Univ. of California (1969). 235p. University Microfilms Order No. 70-8167.

Thesis.

This dissertation is composed of three almost independent parts; the abstracts are therefore separate. Three experimental studies were performed to determine: the uranium isotopes in sea floor phosphorites; the uranium in an anoxic fjord; and the carbon and oxygen isotopes in apatite CO_2. Analyses using α-spectroscopy techniques of uranium concentration and $^{234}U/^{238}U$ activity ratios were performed on 40 samples of marine phosphorites, almost all of them dredged from the sea floor. In each sample, the concentration and isotopic composition of total uranium and U(IV) were analyzed. Uranium concentrations in the analyzed nodules vary between 6 and 524 ppM, tetravalent uranium constituting 38-84% of the total. Whereas the mean activity ratio for total uranium is 0.97, the ratio in the U(IV) uranium is 0.71 and the calculated activity ratio for U(VI) uranium is 1.57. This indicates that: all the analyzed nodules are old (probably older than 8×10^5 years), and are at the present being eroded rather than deposited and the difference in isotopic ratios between the two oxidation states of uranium generally confirms previously proposed mechanisms of uranium isotope fractionation. Differential oxidation of ^{234}U is largely responsible for the measured $^{234}U/^{238}U$ disequilibrium ratios. A model for evolution of uranium isotope activity ratios in different oxidation states is presented. A fairly simple chemical fractionation technique was tested for separation of authigenic uranium from its detrital counterpart. $^{234}U/^{238}U$ activity ratios can serve as an excellent indicator for testing the efficiency of such a technique. Uranium is effectively removed from sea water into anoxic sediments. This process is extremely fast compared to the rate of removal into deep sea sediments. Authigenic uranium is most strongly correlated with organic carbon content of the sediments, probably because of the formation of organo-uranyl complexes. Analysis of interstitial waters can serve as an indicator for the chemical state of uranium in the solid phases. About half of the uranium in sediment from the center of Saanich Inlet is strongly bound (as a chemical complex) to organic matter. The other half is about evenly divided between detrital minerals, authigenic tetravalent uranium, and uranium adsorbed on organic matter. Analysis of stable carbon and oxygen isotopes has been applied to a solution of a mineralogical problem: elucidation of the relation of the carbonate ion to the apatite structure. Calcite was separated from coexisting apatite in pelletal phosphorites, phosphatized limestones and synthetically prepared apatites by dissolving calcite in triammonium citrate. Both calcite and apatite CO_2 were then analyzed for carbon and oxygen isotopes. Carbon and oxygen in the CO_2 associated with apatite are enriched in their light isotopes as compared to the coexisting calcites. This indicates that carbonate ion is a structural part of apatite, a conclusion which is in accord with other mineralogical studies. (Diss. Abstr. Int., B)

46351 DETERMINATION OF GEOLOGICAL AGE OF SOME BULGARIAN MICA BY METHOD OF THE U FISSION FRAGMENT TRACKS. Kashukeev, N.; Taneva, T.; Ignatova, R.; Neova, I. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 559-62(1970). 22(In Russian).

The geological age of Bulgarian mica was measured using the spontaneous fission of ^{238}U. The density of fission tracks during spontaneous and induced fission and the magnitudes of integral thermal neutron fluxes were used for calculating the geological age of the specimens of mica-muscovites in pegmatite deposits in Rile, Village Smilovore, and West Rodopa. Data obtained were in agreement with that obtained by the lead method. (R.V.J.)

46352 LEAD AND STRONTIUM ISOTOPES IN ROCKS OF THE ABSAROKA VOLCANIC FIELD, WYOMING. Peterman, Zell E.; Doe, Bruce R.; Prostka, Harold J. (Geological Survey, Denver). Contrib. Miner. Petrol.; 27: 121-30(1970).

The Absaroka volcanic field is comprised of predominant andesitic volcaniclastic rocks and less abundant potassium-rich mafic lavas (shoshonites and absarokites). Strontium and lead isotopic variations preclude a simple derivation from an isotopically uniform source: $^{87}Sr/^{86}Sr$, 0.7042 to 0.7090; $^{206}Pb/^{204}Pb$, 16.31 to 17.30; $^{208}Pb/^{204}Pb$, 36.82 to 37.64. It is postulated that these rocks were derived from a lower crust or upper mantle which underwent a preferential loss of uranium relative to lead approximately 2800 ± 200 Myr ago. Variations in lead and strontium isotopic compositions are thought to reflect small inhomogeneities in U/Pb and Rb/Sr ratios in the source. (auth)

Meteorology

Refer also to abstracts 46299, 46300, 46392, 46472, and 46817.

46353 (AERE-R-5898) METHODS OF COLLECTION AND ANALYSIS OF RADIOACTIVITY FROM DISTANT NUCLEAR TEST EXPLOSIONS. Cambray, R. S.; Fisher, E. M. R.; Salmon, L.; Brooks, W. L. (Atomic Energy Research Establishment, Harwell (England)). Jul 1970. 23p. Dep. CFSTI (U. S. Sales Only). UK 4s.

The methods used for the collection and analysis of fallout samples from a worldwide network of sampling stations are summarised. Rainwater is collected by funnel and bottle. Airborne dust is sampled by filters near ground level and occasionally in the upper troposphere and lower stratosphere. The total beta activity is measured by simple counter arrangements and individual fission products by gamma ray spectrometry and radiochemistry. The operating instructions to rainwater collectors, the radiochemical analytical procedures, and the method of numerical analysis of gamma ray spectra are described in Appendices. (auth) (UK)

46354 (EGG-1183-1481) NEVADA AERIAL TRACKING SYSTEM (NATS): BEATTY WASTE DUMP SURVEY. Technical Report No. L-991. Boyns, P. K.; Sevart, M. D. (EG and G, Inc., Las Vegas, Nev.). 26 May 1970. 13p. Dep. CFSTI.

An aerial survey of the Beatty Waste Dump and surrounding vicinity at the Nevada Test Site was performed on Feb. 25 and 26 and May 8, 1970 to determine the γ radiation spectra and gross γ radiation count rate for the area. The equipment and procedures used are described, and the results are plotted. (L.C.L.)

46355 (HASL-235) PLUTONIUM IN SOIL AROUND THE ROCKY FLATS PLANT. Krey, P. W.; Hardy, E. P. (New York Operations Office (AEC), N. Y. Health and Safety Lab.). 1 Aug 1970. 44p. Dep. CFSTI.

Soil samples were collected to a depth of 20 cm at 33 sites extending as far as 40 miles from the Dow Chemical Co.'s Rocky Flats plant in Colorado. Deposition concentrations of ^{239}Pu as high as 2000 mCi/km^2 were found off the plant site but these high concentrations decreased rapidly with distance. The contamination pattern extends eastward from the plant in the direction of the resultant wind vector and has virtually no westward component. The pattern is incompatible with the wind direction of the day of the May 11, 1969 fire. Leaking barrels of plutonium laden cutting oil stored in the southeast corner of the plant are considered the likely source of the contaminant. Three mCi/km^2 of ^{239}Pu is the lowest contour readily discernible in the contamination pattern and extends about 8 miles east and southeast of the plant. The inventory of Rocky Flats ^{239}Pu within the 3 mCi/km^2 contour but excluding AEC controlled land is 2.6 Ci. The extent of the Rocky Flats ^{239}Pu beyond this contour is difficult to determine because the deposition of ^{239}Pu from nuclear weapon tests fallout is not precisely known in the Denver area. The cumulative fallout ^{239}Pu is estimated at 1.5 mCi/km^2 based upon a 1965 soil sample from nearby Derby, Colorado. The most distant sites at 40 miles to the east and north of the plant show a slightly higher value of 2.0 mCi/km^2. The intervening sites average 2.4 mCi/km^2. If the extreme and unlikely assumption is made that the entire area lying 40 miles to the east and north of the plant is contaminated with 1 mCi/km^2, an additional 3.2 Ci of Rocky Flats plutonium could have been released to these remote areas. Strontium-90 determinations for the Rocky Flats soils and other studies are in process which might resolve this uncertainty in the remote areas, but additional sampling may be required to solve the problem. The plutonium has been shown to move down into the soil as far as 13 cm, although the distribution shows wide variability apparently depending upon soil chemistry. In several cases there is as much as 60% of the total plutonium below 5 cm. The analytical precision of aliquoting the sample and analysis was shown to be ±20%. Analyses of duplicate samples taken from the same location showed similar precision indicating that the soil sampling was representative of the area studied. (auth)

46356 (POR-1818) SOME RADIOLOGICAL OBSERVATIONS AND CHARACTERISTICS OF FALLOUT DEBRIS FROM A NUCLEAR CRATERING EXPERIMENT, SHOT DANNY BOY. Project 2.4 [of] Operation Nougat II: Shot Danny Boy. Mork, Harold M.; Larson, K. H.; Wood, R. A.; Kowalewsky, B. W. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology). Jul 1970. Contract AT(04-1)-Gen-12. 32p. (WT-1818). Dep. CFSTI.

The fallout pattern from a nuclear device buried in hardrock (basalt) at 33.5 meters below ground surface was delineated by ground survey from the edge of the ejecta out to 7.6 kilometers. An aerial radiometric survey further extended the fallout pattern to about 165 kilometers downwind from the detonation. The distribution of radioactivity per unit area, mass per unit area, and radioactivity per unit mass and particle size were determined. There was little correlation between activity per unit mass and activity per unit area; specific activity varied inversely with particle size. Radioactive decay of samples from selected locations in the pattern showed negative slopes of about 1.3 for the time interval from H + 45 to H + 260 hours. There was a significant increase in the less-than 44 micron size fraction with increase in distance from ground zero. More than 70 percent of the radioactivity was associated with this size fraction. Limited data on radionuclides indicated some fractionation with distance. (auth)

46357 (SC-RR-70-411-A) STATISTICAL AND OTHER INFORMATION CONCERNING THE ELECTRICAL POTENTIAL GRADIENT. Armbrust, E. F. (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. 30p. Dep. CFSTI.

A brief résumé of the atmospheric electrical potential near the earth's surface is presented along with information on the dangers of high potential gradients, especially when explosives are being handled. Information on the local environment and the adaptation of a radioactive probe for measuring gradients is also given. Included is an analysis of the potential gradient measurements taken over a period of 1 year within Sandia Laboratories work areas. (auth)

46358 SEASONAL VARIATION OF ^{7}Be RELATIVE TO ^{137}Cs IN SURFACE AIR AT TROPICAL AND SUB-TROPICAL LATITUDES. Rangarajan, C.; Gopalakrishnan, Smt. S. (Bhabha Atomic Research Center, Trombay, India). Tellus; 22: 115-21(1970).

A comparative study of the seasonal variations of cosmic-ray produced ^{7}Be and fission product ^{137}Cs was carried out in the surface air at Bombay and other stations in India. The results show that both isotopes attained peak values during the spring months of March and April. However, it was observed that the amplitude of increase was much less in the case of ^{7}Be compared to stratospheric ^{137}Cs. This difference is explained as being due to only a part of ^{7}Be in surface air being of stratospheric origin. By comparison with ^{137}Cs, it was estimated that the stratospheric component of ^{7}Be is about 60% in spring decreasing to 25% in the autumn. (auth) (Sweden)

46359 HIGHLIGHTS OF GSC AIRBORNE GAMMA SPECTROMETRY IN 1969. Darnley, A. G.; Grasty, R. L.; Charbonneau, B. W. (Geological Survey of Canada, Ottawa). Can. Mining J.; 91: 98-101(Apr 1970).

Experiments in both the Bancroft and Uranium City areas have confirmed the importance of both uranium to thorium and uranium to potassium ratios as indicators of localized uranium concentration. Methods are described and summaries given. (F.S.A.)

46360 PHASE RELATIONS AND TERRITORIAL REPRESENTATIVITY OF DAILY AVERAGES OF LONG-LIVED TOTAL β ACTIVITY OF AEROSOLS. Zier, Manfred (Meteorologisches Observatorium, Wahnsdorf, Ger.). Beitr. Geophys.; 78: 323-33 (1969). (In German).

By means of cross-correlation functions and measures of determinancy of the daily mean total β activity of the air between January 1963 and September 1964 phase relations and representativity of the measured values are discussed. In the period of a month the phase differences are compensated in most cases by taking into consideration stations with a maximal distance of 250 km. Correlation coefficients are higher in summer than in winter, but vary considerably from month to month. High correlation was observed under cyclonic weather conditions, low correlation under anticyclonic conditions. The measure of determinancy decreases with increasing distance between the stations. In the measuring grid of the Meteorological Service of the G.D.R., about 80% of the activity variations of a station in summer and about 60% in winter can be represented by those of an adjoining station, the mean distance between them being 130 km. Inversion and fog cause a low correlation between mountain and valley stations in winter. (auth)

46361 METEOROLOGICAL NOTES ON TRAVEL OF DEBRIS FROM AN ATOMIC EXPLOSION AT MURUROA ON 7 JULY 1968. Hawson, C. L. Meteorol. Mag.; 99: 165-70(Jun 1970).

The likely dispersal of debris from the first of a series of atomic explosions at Mururoa in July 1968 is considered, including spread by eddy diffusion. Times of first detection at Pretoria, Aspendale and Bombay of debris from this explosion are compared with tracks and times inferred from charts of average upper winds over the world for July and their associated standard vector deviations. Good agreement is found. In particular, rapid interhemispheric exchange in the lower troposphere is in accord with recent studies of wind fields over the Indian Ocean. (auth)

46362 DATA. SECTION III. AIR AND DEPOSITION. Radiol. Health Data Rep.; 11: 349-55(Jul 1970).

The gross β radioactivity in surface air and precipitation in the United States and Canada during March 1970 is given. Samples were collected at stations along the Radiation Alert Network (RAN) and the Canadian Air and Precipitation Monitoring Program network respectively. The gross β radioactivity in surface air as sampled by the Pan American Air Sampling Program is also given for March 1970. Selected RAN stations are reporting the tritium content of precipitation. These data are given for July to December 1969. (E.R.B.)

46363 THEORETICAL APPROACH TO THE SUESS EFFECT. Baxter, M. S.; Walton, A. (Univ. of Glasgow). Proc. Roy. Soc. (London), Ser. A; 318: 213-30(11 Aug 1970).

From a theoretical study of the production and distribution of fossil-fuel carbon dioxide released since the beginning of the Industrial Revolution calculations were made of the resultant decreases in atmospheric carbon-14 specific activities (Suess effect). The calculations are based on recent advances in the assessment of parameters which control carbon circulation and a re-evaluation of the combustion rates of fossil fuels. Results show that the reduction in carbon-14 specific activities amounted to −0.5, −3.2 and −5.9% in A.D. 1890, 1950 and 1969 respectively. Analyses of biospheric materials of known age show good agreement between the predicted and observed atmospheric carbon-14 concentrations, although the possibility exists of a perturbation of natural origin. The incorporation of significant amounts of fossil fuel carbon into 1890 wood indicates the possibility of error in radiocarbon analyses based on the conventional modern reference material. The study also enables corrections to be made for the Suess effect to observations of carbon-14 activities of samples grown during the past century. Predictions of future consumption of fossil fuels have permitted evaluation of the approximate magnitude of the future Suess effect. The results imply that the effect will be of increasing importance, reaching about −23% by 2000 and −50% by 2025. The Suess effect, which is in competition with the nuclear bomb effect, may therefore reduce atmospheric carbon-14 concentration to the natural level again by 1990. Future increase in atmospheric carbon dioxide levels could have significant climatological consequences, but the magnitude of these changes remains speculative. (auth) (UK)

46364 STUDY ON THE VERTICAL TRANSPORT OF ^{90}Sr AND ^{137}Cs IN THE SURFACE WATERS OF THE SEAS AROUND JAPAN. Nagaya, Yutaka; Nakamura, Kiyoshi (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiat. Res.; 11: No. 1, 32-43(Mar 1970).

A model was established for estimation of vertical transport of ^{90}Sr and ^{137}Cs in surface waters of the sea. In the upper 500 meters of the open seas around Japan, approximate residence times concerning vertical transport were estimated as 5 yr for ^{90}Sr and 3 yr for ^{137}Cs. For the coastal waters, the residence times seemed to be lower than those on open seas. Slight differences of the rates of vertical transport are observed among three regions and between ^{90}Sr and ^{137}Cs. (auth)

46365 WHAT HAPPENS TO AIR POLLUTANTS. Technol. Rev.; 71: No. 9, 75-6(Jul-Aug 1969).

The AEC is making a comprehensive study on rainfall "cleaning" the air. Gas pollutants and particles are traced into clouds. They progress through clouds, water droplets, ice crystals, and ultimately descend in rain. The survey is being made over the Illinois State Water Survey's rain gage network. The data gleaned from this study will assist in predicting the fate of atmospheric radioactive materials, as well as SO_2 and lead from car exhaust. Scientists hope that future electrochemical conversion processes will prove economical for power and chemical companies so that they will be able to curb their SO_2 emission. (Meteorol. Geoastrophys. Abstr.)

46366 TOTAL RADIOACTIVITY AND THE WEATHER. Rocznik, Karl. Meteorol. Rundsch.; 22: 144-6(Sep-Oct. 1969). (In German).

The relationship between total atmospheric radioactivity, precipitation, wind and atmospheric temperature; the daily variation of total radioactivity, the possibility of the action of atmospheric tides upon natural and artificial radioactivity, and the relationship between total radioactivity and weather situations are examined on the basis of total radioactivity measurements made in Regensburg from 1963 to 1967. For the five year mean, Oct. showed the greatest deviation from the mean total radioactivity and June the least. October also showed the greatest amplitude between minimum and maximum total radioactivity and April the least. The 5-yr mean of total radioactivity and the weather factor (WF), expressed by $WF = NS + 10 \cdot NT + 10 \cdot WT/3$ (NS is the monthly precipitation total, NT the number of days with at least 1.0 mm precipitation, WT the number of days with wind velocity at least 10.8 m/sec), showed an inverse relationship throughout the year. Precipitation and wind are the principal factors reducing natural radioactivity. The daily variation of total radioactivity at Regensburg shows the well known fluctuations associated with atmospheric temperature and humidity; the oscillations have a high amplitude in the case of radiation weather and a low amplitude during westerly weather and maritime air. In this case, the wind conditions and the aerosol content of the air play the dominant role. The maximum total radioactivity in Regensburg is between 5 to 9 hr, particularly 7 hr, and the minimum at 15 to 19 hr. On the basis of total radioactivity, which is taken as representative of natural radioactivity, there could not be established a 14- or 28-day fluctuation, thus no association with the lunar period. Tabulated and graphic data are presented on the mean total atmospheric radioactivity in Regensburg (1963 to 1967), the fraction of artificial radioactivity in total radioactivity for 1963 to 1968, the frequency of daily maxima and minima of total and residual radioactivity for 1965 to 1967 (%), the mean values of total atmospheric radioactivity in the 4 lunar phases, the total radioactivity in different air masses, etc. (Meteorol. Geoastrophys. Abstr.)

46367 EQUATION OF MASS CONTINUITY FOR RADON AND ITS DECAY PRODUCTS. Staley, D. O. (Univ. of Arizona, Tucson). J. Geophys. Res.; 75: 5293-4(20 Sep 1970).

An equation for expressing the local change of atmospheric concentration of Rn and Rn decay products is derived. (L.C.L.)

46368 AUTUMNAL PEAK IN ^{109}Cd FALLOUT IN PRECIPITATION AT CALGARY, CANADA. Ezemenari, F. R. C. (Meteorological Service of Canada, Toronto); Prescott, J. R. J. Geophys. Res.; 75: 5271-5(20 Sep 1970).

After the thermonuclear explosion of July 9, 1962, at 400 km over Johnston Island (17°N, 169°W) in which some ^{109}Cd was specially produced, measurements were made at the University of Calgary to determine the concentration of ^{109}Cd in precipitation since early 1964. The results showed a late summer to fall peak as well as the well-known spring maximum in radioactive fallout. Profiles of total β activity in Calgary precipitation also indicated late summer to fall increases during cessation of nuclear testing in 1963 and 1964. (auth)

46369 USE OF ISOTOPIC DECAY RATES IN TURBULENT DISPERSION STUDIES. Beran, M.; Assaf, G. (Weizmann Inst. of Science, Rehovot, Israel). J. Geophys. Res.; 75: 5279-85(20 Sep 1970).

The differences in isotopic decay rates have been used to determine information about time-dependent turbulent dispersion from steady-state measurements. Two approaches to this problem are presented. In the first we consider the problem of determining mean horizontal transport. The transport results from vertical turbulent dispersion coupled with a mean horizontal wind that has a vertical gradient. In the second we treat the problem of dispersion of a source material embedded in an infinite turbulent medium. With both methods a Laplace transform of the form $\int_0^\infty e^{-\lambda s} K(s)\, ds$ (where $1/\lambda$ is the characteristic isotopic decay time) is the key element in the solution. Application to atmospheric and oceanographic conditions is discussed. (auth)

Mineralogy and Exploration

Refer also to abstracts 46344, 46359, and 46506.

46370 (CEA-N-1279) COMPUTER CALCULATION OF γ-LOGGINGS IN URANIFEROUS DEPOSITS. Coulomb, Rene; Desgeans, Jacques; LeQuan, Lucien; Salichon, Maurice (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 45p. (In French). Dep. CFSTI (U.S. Sales Only).

The mathematical method and the FORTRAN program used for 3 years for routine interpretation of γ-loggings in uraniferous deposits are described. This method is only one step in the overall program for using field data for the estimation and economical optimization of orebodies. All the stages of calculation are permanently checked and visualized by digital tracers or an IBM 2250 conversational computer. (auth) (France)

46371 (NP-18435) URANIUM: RESOURCES, PRODUCTION, AND DEMAND. (European Nuclear Energy Agency, Paris (France). International Atomic Energy Agency, Vienna (Austria)). Sep 1970. 54p. OECD $3.00.

Data, based on information available in April 1970, are presented on the estimated resources of U in 18 worldwide countries excluding Eastern Europe, People's Republic of China, and the USSR. U resources and production in each country are discussed. The world reserves of Th are estimated. The appendixes contain

information on future U demand, demand and production of enriched U, and the existing capacity of UF_6 conversion plants. (L.C.L.)

46372 (RME-157) PRELIMINARY RECONNAISSANCE FOR URANIUM IN GRAHAM, GRANT, GREENLEE, AND MARICOPA COUNTIES, ARIZONA, 1950-1957. (Grand Junction Office (AEC), Colo. Geological Survey, Denver, Colo.). Jun 1970. 62p. GPO $0.60.

Data obtained from 1950 to 1957 at 58 locations in Graham, Grant, Greenlee, and Maricopa Counties, Arizona which were prospected for U deposits are presented and include information on geographical location, mine or property history, radioactivity measurements, and description of deposit. (L.C.L.)

46373 GENETIC INTERPRETATION OF EPIGENETIC ALTERATIONS IN SEDIMENTARY ROCKS. Lisitsin, A. K.; Kondrat'eva, I. A.; Komarova, G. V. Litol. Polez. Iskop.; No. 3, 5-19(1969). (In Russian).

The correlation between compositions of surface waters and authigenous minerals of the last stage of epigenetic alteration was observed in rocks of water-bearing horizons in some ore deposits. A comparison of mineralogical-geochemical zoning of rocks with hydrogeochemical zoning of waters was used to restore conditions of epigenetic mineralization of several U deposits in the U.S.S.R. The conditions of epigenetic mineralization can be determined directly on complete agreement of epigenetic and hydrogeochemical zoning. A partial agreement of these zonings, observed during study of U deposits, was interpreted by comparison of ore-controlling epigenetic zoning with hydrogeochemical zoning in petroleum-bearing carbonate rocks of the area. It suggested that epigenetic mineral association was formed by intrusion of infiltration waters into petroleum-water horizon. Complete disagreement of recent hydrogeochemical environment with paleohydrogeological conditions of ore formations was observed in the U-Se deposit in continental varicolored stratum. The correlation of hydrogeological and geochemical conditions of deposit formation was then made from lithologic facies and mineralogical geochemical studies. Formation of U and Se concentrations was attributed to ground waters leaching proluvial formations rich in fragments of acidic effusive rocks. Precipitation of U and Se occurred in the zone of reducing geochemical barrier confined to the boundary of proluvium with river bed deposits rich in plant remnants. The climate during ore deposition was semiarid according to the paleogeographical study, which promoted increase in U and Se concentrations in ground waters by water evaporation. (Selenium-Tellurium Abstr.)

46374 PRESENCE OF SUPERGENE URANIUM MINERALS IN HYDROTHERMAL DEPOSITS. Andronescu, A. Rev. Minelor (Bucharest); 20: 225-8(Feb 1969).

Optical, x-ray and ir absorption spectrometry identified: parapitchblende, uranates, clarkeite, fourmasierite and curite, silicates (kasolite, uranophane and sodyte), sulphates (johanite and uraconite, and masuyiate (a hydrated U oxide). (Fuel Abstr.)

46375 GEOCHEMICAL STUDY ON THE GENESIS OF NINGYOITE, THE SPECIAL CALCIUM URANOUS PHOSPHATE MINERAL. Kajitani, Kei (Government Industrial Research Inst., Nagoya, Japan). Econ. Geol.; 65: 470-80(Jun-Jul 1970).

Uranium in sedimentary deposits in the neighboring areas of Ningyô-tôgé, Japan was transported to its present environment from a granite by low-temperature aqueous solution containing dissolved carbonates and oxygen. The granite that supplied uranium was correlated with the basal granite on which the uranium-bearing strata were resting. Uranium was precipitated by a reducing environment induced by organic matter, microorganisms or pyrite. Phosphorus and sulfur in these deposits were directly or indirectly affected by microorganisms. Phosphorus to form ningyoite was fixed in the present deposits before the penetration of uranium-carrying water. Whether ningyoite $CaU(PO_4)_2 \cdot 2H_2O$ or uraninite UO_2 is generated depends upon the dominant reducer in the environment, but does not depend upon the abundance of phosphorus in the environment. Many uraninite ores in which ningyoite was not recognized contain considerable amounts of phosphorus. For the formation of ningyoite, fixation of much sulfur in comparison with carbonaceous matter should occur before the penetration of uranium-carrying solutions. A considerable supply of sulfate into these areas would be required for the abundant accumulation of sulfur. A sulfate supply might be obtained by penetration of low-temperature hydrothermal solutions or decomposed products of hydrothermal deposits dissolved in ground water. Sulfate would be reduced to sulfide by sulfate-reducing bacteria, producing pyrite. For the formation of ningyoite, these processes should occur in a particular order in sedimentary beds on or near the granite basement before the penetration of uranium-carrying water. (auth)

46376 URANIUM RECONNAISSANCE IN NORTHERN SCOTLAND. Bowie, S. H. U.; Ostle, D.; Gallagher, M. J. (Inst. of Geological Sciences, London). Inst. Mining Met., Trans./Sect. B; 79: 180-2(Aug 1970).

In 1968 the Institute of Geological Sciences undertook a five year program aimed at a preliminary assessment of the uranium mineral deposits of selected areas of the U.K. on behalf of the UKAEA. North Scotland is considered here and the geology of the Caithness area which was under investigation briefly described. Due to the extensive peat and drift cover the investigation was based on the geochemical sampling of stream water and sediment and the selective traversing of favorable areas by portable radiation detectors. The primary reconnaissance was completed by the end of 1969. Uranium mineralization in Old Red Sandstone arkose was discovered and numerous radioactive anomalies are mentioned. The average uranium content over an exposed section of Old Red Sandstone was estimated at 50 to 100 ppM, with the existence of higher values at depth. Nonradioactive base metal occurrences, fracture controlled Pb, Zn, Cu and F mineralization with a concentration of 500 ppM Mo in Old Red Sandstone shale were also discovered. Uranium was found to be more widespread than had been realized and shallow to medium depth drilling is recommended at one or two localities. Secondary findings are discussed. (UK)

Oceanography

Refer also to abstracts 46350 and 46472.

46377 (RLO-2225-T-20-1) RADIOCARBON IN THE SEA. Fairhall, A. W.; Buddemeier, R. W.; Yang, I. C.; Young, A. W. (Washington Univ., Seattle). [1970]. 36p. Dep. CFSTI.

Of the world inventory of natural ^{14}C, estimated to be 51 metric tons, over 90% resides in the oceans. Atmospheric testing of nuclear weapons increased this supply by about 3%, producing a dramatic increase in ^{14}C concentrations of atmospheric CO_2 during the mid-1960's. This excess ^{14}C is rapidly being equilibrated with the mixed layer of the sea, raising the ^{14}C concentration of surface ocean water by about 30% over its pre-atomic era level. This increase in ^{14}C serves as a tracer for studying the mixing and advection of surface water into the deep ocean. A simple method for collecting water samples and extracting CO_2 from them on board ship is described. The CO_2 samples are returned to the laboratory for ^{14}C counting. Data from a variety of ocean stations are given and their significance is discussed. (auth)

46378 RADIUM IN THE INDIAN-ANTARCTIC OCEAN SOUTH OF AUSTRALIA. Ku, T. L. (Woods Hole Oceanographic Institution, Mass.); Li, Y. H.; Mathieu, G. G.; Wong, H. K. J. Geophys. Res.; 75: 5286-92(20 Sep 1970).

The Antarctic Convergence forms a distinct boundary for surface radium distribution. To the south of the convergence radium concentrations near the surface are close to 8×10^{-14} g/l, and those of the deep waters, 10×10^{-14} g/l. To the north surface concentrations drop to 4×10^{-14} g/l, whereas bottom values remain near 10×10^{-14} g/l, the transition being at a depth below 500 meters. Radium distribution in this part of the ocean strongly reflects the influence of advection and water-mass movement. Also, downward transport of radium through particle settling is clearly demonstrated. The nature of the radium-bearing particles in the ocean may be closely related to siliceous organisms. (auth)

Seismology

Refer also to abstracts 46300, 46383, 46384, 46403, and 47319.

46379 (NVO-1163-217) MODELS FOR GENERATING SYNTHETIC SEISMOGRAMS. Lynch, Robert D.; Murphy, John R.; Hays, Walter W.; Williams, Spencer L. (Environmental Research Corp., Alexandria, Va.). Aug 1970. Contract AT(29-2)-1163. 75p. Dep. CFSTI.

Two models for the generation of synthetic seismograms are described. The first model derives a seismogram by applying a time-varying filter to a white noise source. The second model uses an observed seismogram as input to an analog filter realization of a deterministic model of the seismic source function for underground nuclear detonations. The seismograms generated by these models are compared with actual measured seismograms and the agreement between the two is shown to be quite satisfactory. The results of this study, although preliminary, represent a technique having great utility in predictive studies related both to underground nuclear testing program and to the field of earthquake engineering. Recommendations for extending the results of this study are given in the context of developing the capability to predict accurately the time history expected at a given site from either an underground nuclear explosion or an earthquake. (auth)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 46353 and 46356.

46380 (PNE–1114) PROJECT PRE-GONDOLA III, PHASE I SUMMARY REPORT. Cress, J. P.; Lattery, J. E.; Andrews, J. B.; Warden, F. F. (Army Engineer Nuclear Cratering Group, Livermore, Calif.); Vortman, L. J. (Sandia Corp., Albuquerque, N. Mex.). Apr 1970. 78p. Dep. CFSTI.

Project Pre-Gondola III, Phase I, a continuation of chemical-explosive cratering experiments conducted in saturated clay-shale near Fort Peck, Montana, was designed to excavate a row crater with relatively flat side slopes. This was accomplished by detonating three parallel row charges, each row containing seven 1-ton charges of nitromethane. The two outside rows were detonated as the first pass, and the center row was detonated as the second pass. The final apparent crater had a width of 169 ft, a depth of 11.2 ft, and average slopes of 1 on 5.4. The technical programs conducted during the experiment were: measurements of the apparent crater; surface-motion analysis; cloud-development studies; and airblast measurements. (auth)

46381 (SC-RR-70-492) DIMENSIONS OF CRATERS PRODUCED BY SIMULTANEOUS DETONATION OF TWO PARALLEL ROWS OF CHARGES. Vortman, L. J. (Sandia Labs., Albuquerque, N. Mex.). Sep 1970. 19p. Dep. CFSTI.

The crater produced by detonations of a double row of explosives provides a more favorable profile than that of a single row, where the crater is to be used as a channel through an unstable medium. The crater profile from double rows of 64-pound charges offers a sounder basis than that from double rows of 8-pound charges for the purposes of estimating the amount of material to be moved to shape crater side-slopes into a stable configuration for a channel. (auth)

46382 (UCRL–50865) SURVEY OF PILEDRIVER RESULTS AND PRELIMINARY INTERPRETATION OF THREE POSTSHOT CORES IN AND NEAR THE CAVITY. Borg, I. Y. (California Univ., Livermore. Lawrence Radiation Lab.). 29 Apr 1970. 67p. Dep. CFSTI.

A summary of measured data collected by numerous agencies cooperating in the Piledriver event (61 ± 10 kt in granodiorite, June 2, 1966) is presented together with calculations based on empirical relations deduced from past events in comparable media. Highlights include the following: peak measured radial pressure experienced by surviving rock was 250 to 270 kb; at 350 m from the present cavity edge the radial pressure was <1 kb; radius of the spherical mass of rock vaporized and melted is 15.6 m; the displacement "heave" is at a maximum at the cavity edge, 24.5 m, and is less than 0.3 m at 305 m from the shot point; measured cavity radius is 40.1 m. Of nine relations that have been proposed to predict cavity radius, five result in radii accurate to <3.5%. The remainder are off by about 10 to 18%. The shape of the Piledriver chimney is known to depart from that of a cylinder with semihemispherical ends. The 13° cant measured on the SW wall is probably due to collapse and shearing along pre-existing planes of weakness which are part of a regional pattern. By analogy with information from the Hardhat chimney exploration in the same igneous body, the Piledriver chimney may in fact have nearly vertical walls on the unexplored NE side and thus be axially asymmetric. It is possible that further exploration in the Hardhat chimney would reveal a similar asymmetry. Three postshot recovered cores (U-15.01 PS-1, -2, -3) were examined on a gross scale prior to extensive detailed sampling for laboratory tests. The positions of injected glass seams, radioactivity, and shear zones were recorded. The orientation of several thousand core fractures was measured with respect to the core axes and distance from the shot point. Although cores and the fractures they contain cannot be uniquely oriented in space, it can be demonstrated that the fractures are not randomly oriented with respect to the shot point and that they have attitudes consistent with failure along the four major and several minor pre-existing fracture and/or joint sets. In general their positions are not consistent with radial or tangential fracturing. The test for shear failure cannot be applied satisfactorily to the data at hand. Taking all observations into account, phenomena related to failure of rock in the Piledriver event are closely related to pre-existing weaknesses and inhomogeneities. (auth)

46383 NUCLEAR EXPLOSIONS AND DISTANT EARTHQUAKES: A SEARCH FOR CORRELATIONS. Healy, J. H.; Marshall, P. Anthony (National Center for Earthquake Research, Menlo Park, Calif.). Science; 169: 176–7(10 Jul 1970).

An apparent correlation between nuclear explosions and earthquakes was reported for the events between September 1961 and September 1966. When data from the events between September 1966 and December 1968 were examined, this correlation disappeared. No relationship between the size of the nuclear explosions and the number of distant earthquakes is apparent in the data. (auth)

46384 BOMBS AND EARTHQUAKES. Newstead, G.; Pile, M. (Australian National Univ., Canberra). Nature (London); 227: 317–18(18 Jul 1970).

Reference is made to the New York Times of May 9th 1970 in which it was stated that two severe earthquakes followed underground nuclear explosions. Since then there has been much uninformed speculation in the press as to whether the recent Peruvian earthquake could have been triggered by the French nuclear test the previous day (May 24th, 1970). The purpose of the present communication is to advance both general and statistical arguments which lead to an opposite view. (UK)

46385 MINING APPLICATIONS OF UNDERGROUND NUCLEAR EXPLOSIONS. Com. Naz. Energ. Nucl., Notiz.; 16: 84–6(Jun 1970). (In Italian).

Information obtained at the Jan. 1970 Symposium on Industrial Applications of Nuclear Explosives at Las Vegas is used to discuss the economic and technical factors to be considered in mining uses of underground nuclear explosions. (auth)

Facilities and Equipment

Refer also to abstracts 46326, 46441, 46446, 46550, 46690, 46691, 47154, and 47186.

46386 (ANL–7658) SELECTED DATA AND DISCUSSION OF THE PLUGGING INDICATOR FOR SODIUM LOOPS. Vilinskas, P.; Filewicz, E. C.; Humphreys, J. R. (Argonne National Lab., Ill.). Jun 1970. Contract W-31-109-eng-38. 16p. Dep. CFSTI.

The differences between manual, continuous, and oscillating plugging indicators in a sodium system are discussed briefly. The experimental data presented were obtained with the manual and the oscillating plugging indicators. The initial results showed that temperatures of manual plugging indicators did not agree with cold-trap temperatures as required by theory. Manual plugging runs were made to determine reasons for the large variation in temperature difference. The cooling rates were varied while maintaining constant plugging-indicator flow rate and cold-trap temperature. These results indicated the trend that at low cooling rates (approaching zero) the plugging temperature would approach cold-trap temperature. Results of work with the oscillating plugging indicator indicated the reasons for the large variation observed with the manual plugging indicators. The manual plugging indicator used in the tests was modified into an oscillating plugging indicator, and successful runs were made in the temperature range of 269 to 400°F. Temperature changes of the cold trap, and hence the impurity concentration of the sodium in the system, were indicated on the temperature trace of the oscillating plugging indicator. The temperature differential between the cold trap and the manual plugging indicator was found to be reduced by operating in the oscillating mode. Premature precipitation was identified as an important factor in the operation of the oscillating plugging indicator. If the heating and cooling area of the plugging indicator is such as to allow precipitation of the impurities upstream from the orifice, then it becomes impossible to operate the device in the oscillating mode. Also, species other than oxide were evident in the test runs. (auth)

46387 (BARC–483) MASKING MACHINE. Chaudhry, Ramesh (Bhabha Atomic Research Centre, Bombay (India)). 1970. 12p. Dep. CFSTI (U. S. Sales Only).

A versatile masking machine for use with work on fabrication of semiconductor detectors has been made. The machine can mask both rectangular and circular areas. The machine is also useful for applying epoxy resins for edge protections or encapsulation of semiconductor detectors. A vacuum hold mechanism is incorporated in the machine for holding the crystal at its platform. Details of facilities and the fabrication of the masking machine are presented. (auth)

46388 (BNWL–CC–2676) HIGH TEMPERATURE CREEP- AND STRESS-RUPTURE APPARATUS FOR REMOTE APPLICA-

TION. Yount, James A.; Smith, Willford F.; Blaisdell, Donald S. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1968. Contract AT(45-1)-1830. 21p. Dep. CFSTI.

A machine used to perform creep and stress-rupture tests to 1600°F with loads to 1500 pounds in inert gas and air environments is described. The machine is compact, lightweight, and designed for remote operation in an irradiation hot cell; its cost is less than one-third that of commercially available test apparatus. (auth)

46389 (CEA-CONF-1563) DETERMINATION OF THE THERMAL CONDUCTIVITY OF DIFFERENT MATERIALS UP TO 1000°C. APPLICATION TO GRAPHITES AND CARBONS, BORON CARBIDE, AND SOME COMPOUNDS BASED ON BORON CARBIDE. Degas, P.; Bertin, J. L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 26p. (In French). (CONF-700422-1). Dep. CFSTI (U. S. Sales Only).

From 2nd Conference on Thermophysical Properties of Solids at High Temperatures, Risley, England.

An apparatus has been developed to measure the thermal diffusivity of solids by the flash method, between room temperature and 1000°C. The thermal conductivity is deduced from these measurements by using the published specific heat values. The apparatus is described briefly. The energy applied on the front face of the sample is provided either by a lamp which delivers an energy 2000 joules per flash, or by a ruby laser of output energy at each impulse adjustable from 1 to 10 joules. The sample, generally in the form of a pellet of diameter around 10 mm, is placed in an insulating stumatite holder. The temperature increase of a few degrees centigrade on the rear face of the sample is detected by means of a thermocouple, the electromotive force variation of which is transmitted to an oscilloscope after amplification. The sample-holder unit is placed in a furnace supplied by direct current to avoid perturbations on the thermocouple signal. The measurements may be carried out under vacuum or under a pressure of gas. The thermal conductivity values determined in this way are compared, for materials of low electrical resistivity, with those obtained by using an apparatus working according to Kohlrausch's method. The materials investigated are liable to be used for the neutron shielding of fast neutron reactors and therefore mainly concern carbons, graphites, boron carbide and compounds containing boron carbide. (auth) (France)

46390 (CONF-700330-2) REMARKS CONCERNING SOLAR FURNACES IN SPACE. Hoez, M.; Foex, M. (Centre National de la Recherche Scientifique, Odeillo (France). Laboratoire des Ultra-Refractaires). 1970. 5p. Dep. CFSTI (U. S. Sales Only).

From Solar Energy Society Conference, Melbourne, Australia.

The possibility of employing solar furnaces in conjunction with the high vacuum of space is examined. Production of high purity products in space, and the inherent difficulties, are considered. (Australia)

46391 (CONF-700810-17) ENERGY RESOURCES FOR POWER PRODUCTION. Hubbert, M. King (Geological Survey, Washington, D. C.). [1970]. 48p. (SM-146/1).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

The world's energy resources for power production are classified as the continuous energy influxes from extraterrestrial sources and from the earth's interior, i.e., solar radiation, geothermal, and tidal energy, and as the chemical, nuclear, and thermal energy stored in the ocean and in the outer part of the lithosphere, i.e., fossil and nuclear fuels. The total potential power which can be produced from each of these sources is discussed. It is concluded that the world's fossil fuel supply will be exhausted in about 3 centuries, that geothermal, tidal, and solar energy sources will be inadequate for power production demands, and that fission power based on ^{235}U will also be short-lived unless breeder reactors are used. However, with complete breeding, the energy obtainable from Th and U would be sufficient to meet the world's power requirements for additional centuries. (L.C.L.)

46392 (COO-401-162) UPPER AIR SAMPLING AND MONITORING PROGRAM. Final Comprehensive Report, April 1956-June 1968. Technical Report No. 3430. Conlon, R. D. (Litton Systems, Inc., Minneapolis, Minn. Applied Science Div.). Jul 1970. Contract AT(11-1)-401. 90p. Dep. CFSTI.

The acquiring of useful data on radioactive debris at high altitudes required the development of balloon-borne particulate sampling systems and of highly sensitive instrumentation for controlling, monitoring, and recording sampling systems performance. The program followed in developing these devices is summarized starting with the first low altitude sampler and finally resulting in third generation sampling devices and sampler performance monitors for operation to altitudes of 140,000 ft. The equipment used in the field today includes the direct flow sampler, the 1000-cfm air ejector sampler, the HV-3000 sampler, the models PR-2 and PR-3 flowmeter, the B-58 densitometer altimeter, and a solid-state, 40-megacycle data transmission system. (L.C.L.)

46393 (IN-1406) EXPLODING WIRE AS A DYNAMIC PRESSURE SOURCE. Meservey, R. H.; Piper, T. C. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 55p. Dep. CFSTI.

A method with which to determine wire behavior during an exploding discharge is described. Using only the original wire dimensions and current and voltage records of the explosion, the following parameters were calculated: wire volume, radius, magnetic pressure, inertial pressure, velocity, acceleration, and electrical energy. Values of the above parameters were calculated for each ½-μsec time interval during the explosion. A range of wire sizes was tested at 5 and 10 kV discharges from an energy storage capacitor. The wire explosions were produced in water and the waterpropagated shock wave was measured for each explosion. Correlations between wire behavior and the shock wave energy indicate that the shock energy is proportional to the radial wire velocity and to the electrical energy deposited in the wire. Although the wire melts early in the energy discharge cycle, it is contained by magnetic and inertial forces. Rapid expansion of the volume occurs at the time of vaporization of the wire material. Time histories of wire behavior are presented for a range of explosion conditions. The exploding-wire-driven shock waves were used to determine the dynamic response characteristics of pressure transducers. The pressure transducer response investigations were conducted on behalf of the Water Reactor Safety Test programs at the NRTS. (auth)

46394 (RFP-1513) IMPROVED RESISTANCE FURNACES FOR MOLTEN SALT EXTRACTION PROCESS. Teter, Alton R.; Long, Jack L.; Leggett, Ronald L.; Smith, Carl J. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). 24 Aug 1970. Contract AT(29-1)-1106. 5p. Dep. CFSTI.

The high failure rate of resistance furnaces used in the process for molten salt extraction of americium from plutonium was investigated. As a result, two new furnace designs were fabricated and tested. Two of the furnaces were operated for 124 and 154 three-hour cycles to 900°C with no indications of element failure. In addition, it was found that the furnaces would melt the 3500-gram mock-up salt charge and maintain a melt temperature of greater than 700°C by applying a power input of 2700 watts for two hours and then reducing the power to 1700 watts for one hour. Past production procedures were to operate the furnaces at 3000 watts during the entire three-hour cycle. The new furnaces are expected to have an operational life of six months, as compared with two months for previous designs, providing element temperatures are not allowed to exceed 1000°C. (auth)

46395 (SZS-13/70) REGENERATION OF ION EXCHANGERS USED FOR THE TREATMENT OF RADIOACTIVE WASTE WATERS. III. LABORATORY INVESTIGATIONS ON WOFATIT AK-40. Johannsen, K.-H. (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). May 1970. 22p. (In German). Dep. CFSTI (U. S. Sales Only).

On a laboratory scale the suitability of the weakly basic anion exchanger Wofatit AK-40 for the treatment of waters containing fission products was investigated. The resin exchange capacity was determined after regeneration of the NO_3^-, HSO_4^- and Cl^- form with NaOH and Na_2CO_3 of various concentrations. The displacement of radionuclides was also determined. The regeneration of Wofatit AK-40 was performed with 4 to 6 bed volumes of 1 N NaOH or Na_2CO_3 resulting in a 95 percent regeneration of the exchange capacity and a 50 percent elution of the radioactivity. The efficiency of the AK-40 is strongly dependent on the salt content of the water. In some cases the results obtained were comparable to those obtained with the Wofatit SBK. The adsorptive properties of AK-40 are the reason for the high activity left on the resin after regeneration. The use of AK-40 as the sole anion exchanger for the decontamination of water is not recommended but it is suitable for the removal of free acids after a KPS filter, as well as for capacity relief following a SBK filter. (auth)

46396 RESEARCH AND DEVELOPMENT AT EUROCHEMIC. Lopez-Menchero, E.; Detilleux, E. Neue Tech., B; 11: 38-42 (1969).

Adapting the processing technique to the evolution of the fuel (burn-up, materials, etc.) and finding safe economical solutions to the waste problems are the principal targets of the present Eurochemic research and development activities; the different aspects of the optimization fit around these two lines. Development should be 5 or 10 years ahead of production problems. The urgency of the solutions coincides with the more or less advanced status of Euro-

chemic's development work. If integrated effort continues, this will allow the company to fulfil the tasks defined by the statutes in the clause "... any research or industrial activity connected with processing of irradiated fuels and the use of the resultant products." (auth)

46397 AUTOMATIC SAMPLE CHANGERS FOR LIQUID SAMPLES AND COINCIDENCE MEASUREMENTS. Graf, H.; Urech, D.; Utzinger, E. (Eidgenoessische Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Neue Tech., B; 11: 58-61(1969). (In German).

An automatic sample changer for the measurement of the activity of irradiated uranium samples in liquid or solid form was built and operated at EIR. The detector consists of a pair of sodiumiodide scintillation counters which operate either as single units or in coincidence. The unit is highly flexible and its method of operation may be easily adapted to meet the varying requirements of the user. All output information is punched on paper tape for direct computer processing. The apparatus was originally used in connection with the subcritical assembly MINOR and it now plays a vital part in the experimental program of the critical assembly PROTEUS. (auth)

46398 NUCLEAR TECHNOLOGY IN RUMANIA. Balanescu, M. Neue Tech., B; 11: 204-5(1969).

The development of nuclear technology in Rumania from 1930 to 1969 is reviewed with emphasis on advances made since the establishment of the Institute of Nuclear Physics in 1949. (L.C.L.)

46399 PROBLEMS IN THE SWISS NUCLEAR INDUSTRY. Kaegi, J. (Gebrueder Sulzer AG, Winterthur, Switzerland). Neue Tech., B; 11: 99-104(1969). (In German).

A classification of the industrial activities in the nuclear field is given. The respective possibilities of the Swiss industry in partnership with reactor manufacturers and with power utilities are discussed. Quality requirements are extremely high (approval system). For certain types of orders a more or less limited contribution to the technical development is possible. The problems of the distribution of risks are mentioned. (auth)

46400 DEVELOPMENT OF ATOMIC POWER MECHANICAL ENGINEERING IN THE USSR. Andreev, P. A.; Gremilov, D. I. Energomashinostroenie; No. 4, 29-30(Apr 1970). (In Russian).

A brief review is given on the development and perspectives of nuclear power plant construction in the Soviet Union. It is indicated that further development of nuclear power would demand a more rapid tempo for production of the necessary thermo mechanical equipment, mainly high-power WWER reactors. Problems of complex optimization of power plant parameters and installation using mathematical simulators and IBM equipment and technological improvements of power production are discussed. (tr-auth) (INIS)

46401 IN-PLACE TESTING OF THE HANFORD REACTOR CHARCOAL CONFINEMENT FILTER SYSTEMS USING IODINE TAGGED WITH ^{131}I. Mecca, J. E. (Douglas United Nuclear, Inc., Richland, Wash.); Ludwick, J. D. Nucl. Appl. Technol.: 9: 508-15(Oct 1970).

A nondestructive in-place test procedure was developed to measure the efficiency for iodine removal by charcoal filters in the Hanford reactors exhaust gas systems. Tests were performed during the past few months on the C, KE, and KW Hanford single pass production reactor systems. Results from tests conducted on individual reactor confinement cells showed iodine trapping efficiencies of from 94 to 99%. The experimental techniques and procedures used also facilitated the simultaneous measurement of iodine plateout in the reactor exhaust duct systems. (auth)

46402 TRAPPING SYSTEM FOR RADIOACTIVE GAS. Corrigan, Kenneth E.; Mantel, Joseph; Corrigan, Henrietta H. (Wayne State Univ., Detroit). Radiology; 96: 571-3(Sep 1970).

A safe and efficient system is described for trapping radioactive gas (xenon) from expired air. The instrument must be protected from CO_2 and H_2O, which would fill its absorbing space, by inserting chemical absorbers for these components ahead of the cryogenic trap. The trap construction is given in detail. (auth)

46403 INFLUENCE OF FOUNDATION CHARACTERISTICS ON RESPONSE OF REACTOR CONTAINMENT STRUCTURES TO GROUND MOTIONS. Schauer, Franz Peter. Ames, Iowa; Iowa State Univ. (1969). 235p. University Microfilms Order No. 70-7734.

Thesis.

The influence that foundation conditions can have in modifying the response of nuclear containment structures to ground motions was investigated. The equations for a lumped parameter representation of a containment structure and its foundation were developed and transformed into a set of equations best adapted to digital computation. In particular, the foundation stiffness and damping properties are conceptually represented as a system of springs and viscous dampers. For the study of foundation stiffness influence, the programmed equations were solved in a modal analysis study of five undamped typical containment structures. For each structure rotational, translational and combined rotational and translational foundation types were studied with the foundation stiffness being the principal variable. The effect of pile type foundations and the effect of neglecting internal system mass and/or inertia were also studied. Foundation stiffness is shown to exert a significant influence on the stress developed in a containment structure from ground motion. A large foundation stiffness value (in comparison with that of the structure, itself) is equivalent to a fixed base condition. Values of foundation stiffness of the order of that of the containment structure are shown to amplify the stress developed in the structure to around twice that developed in the same structure with an assumed fixed base. However, values of foundation stiffness that are small with respect to the stiffness of the structure are shown to reduce structural response to a fraction of that computed to be developed in the same structure when a fixed base is assumed. The importance of accurate knowledge of foundation properties is thus illustrated. In order to study the influence of foundation damping the equations of motion were rearranged into a form suitable for analog computation and the required patching performed on an EAI8800 analog computer. Using an input ground motion that produced a response spectrum representative of an earthquake, the influence of various amounts of foundation translational and rotational damping on the structural response of containment structures was determined. Foundation damping was shown to be considerably more effective than structural damping in modifying structural response. Also, in comparing analog computed damped structural response values with structural response values arrived at by the use of modal analysis, the modal analysis technique was shown to give results that deviated widely from the analog computed values. (Diss. Abstr. Int., B)

46404 SPIRAL MULTILAYER METAL PIPE FOR A PRESSURE VESSEL. Sagara, Hideo; Mashimo, Tomoyuki; Kifune, Takeshi (to Mitsubishi Jukogyo Kabushiki Kaisha). British Patent 1,203,907. 3 Sep 1970. Filed 11 Feb 1969.

Reference is made to pipes of the above type for use for pressure vessels in nuclear power plants, etc. In the manufacture of such pipes a length of steel sheet is wound around an inner cylinder, each end of the steel sheet being made wedged shape either by shaving the steel sheet or by welding a wedge piece to the end of the sheet. Since such wedge portions must usually have a length greater than the radius of the inner cylinder, the machining necessitates much time and cost. In addition, prebending of the sheet at the beginning of the winding operation must be performed carefully so as to fit the sheet end closely to the contour of the inner cylinder. The pipe described comprises an inner cylinder, a metal sheet constituting the main spiral body of the pipe, and thin metal sheets, each of which is thinner than the main pipe and different in length from at least one other such sheet, the sheets being secured to an end of the main sheet so as to form a wedge-shaped end, the collective thickness of the thin sheets being at most equal to that of the main sheet. At least one of the thin sheets may have a rounded or bevelled free edge. (UK)

46405 CRYOSTAT FOR ELECTRON IRRADIATION OF SOLIDS AND POST-IRRADIATION SPECTRAL STUDIES. Albarino, R. V.; Salovey, R. (Bell Telephone Labs., Inc., Murray Hill, N. J.). Appl. Spectrosc.; 24: 418-19(Jul-Aug 1970).

A cell for electron irradiation of solid samples in vacuum at low temperatures and analysis of post-irradiation changes by visible–ultraviolet spectroscopy is described. Liquid nitrogen and constant temperature baths are used to control sample temperature during irradiation and spectral studies. (auth)

46406 HIGH INTENSITY X-RAY SOURCE. Herglotz, Heribert K. (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,502,925. 24 Mar 1970. Filed 14 Mar 1968.

A high-intensity x-ray source incorporating a conical target site, multiple aperture radiation collimation, and electron focusing is described. (auth)

46407 HEAT EXCHANGER. Weber, M. Canadian Patent 845,895. 30 Jun 1970. Priority date 5 Apr 1966, Switzerland.

The nuclear reactor includes a heat exchanger which is constructed with a grate formed by several apertures and upon which a number of heat exchange elements are mounted over the apertures. The grate is disposed within a duct of the heat exchanger so as to divide the duct into an upper and lower chamber. The heat exchange elements are disposed in the upper chamber to conduct a primary coolant into the lower chamber. (F.S.A.)

46408 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS. Gilli, Paul Viktor; Fritz, Kurt (to Waagner-Biro Aktiengesellschaft). British Patent 1,197,348. 1 Jul 1970. Priority date 16 Jun 1967, Austria.

A heat exchanger comprises a pressure vessel and at least two banks of tubes within the vessel. The banks of tubes are so arranged to convey the medium to be heated through the heat exchanger so that the flow of the medium in at least one bank of tubes is in co-current flow to the flow of the heating medium and is in counter-current flow in another bank of tubes. Tubes entering the pressure vessel connect the various banks of tubes to the outside of the pressure vessel. One or more of the connecting tubes run axially and centrally within the vessel and are shielded from the heating medium by one or more centrally disposed heat shields. (B.L.M.)

46409 IMPROVEMENTS RELATING TO FLUID FLOW ARRANGEMENTS USING FLUIDIC SWITCHES IN CASCADE. Grant, John; Fisher, Martin John (to United Kingdom Atomic Energy Authority). British Patent 1,199,938. 22 Jul 1970. Filed 29 Dec 1966.

The system described has as its object a method for investigating main fluid flows in plants, including temperature, presence of impurities, or absence of flow with particular application to nuclear reactors. The arrangement employs fluidic switches having (1) a main flow inlet, (2) a control flow inlet, (3) a first and second main flow outlet to which the main flow can be directed according to signals at the control flow inlet, (4) a supplementary branch in one of the main flow outlets, (5) interconnection from this branch to the control inlet of an adjacent switch, so that control flow through the switches is in series, (6) connections to the main flow inlet and outlets so that main flow through the cascade of switches is in parallel, and (7) a manifold connection to the control flow inlets of all switches. The switches may be bi-stable and the interconnections and manifold connection may be made to the inputs of an AND gate, the output of which connects both with the control inlet of an adjacent switch and the control inlet of its own switch, so that the operations of the two switches are interchanged when the AND gate is operated by a pulse in the manifold connection. Alternatively the switches may be monostable, flow to the unstable positions prevailing when flow exists in the branched main flow outlet, and hence in the interconnection, and the stable position prevailing when flow in the interconnection from the preceding stage ceases. The main flow inlets to the switches may be connected to sampling pipes from the reactor or other plant, the main flow outlets having a supplementary branch connected to a manifold leading to property measuring instruments. (UK)

46410 PROFILE MILLING MACHINE. Filleau, Paul; La-Coste, Jean; Mader, Roger; Pellerin, Achille; Recordier, Roger (to Commissariat a l'Energie Atomique). British Patent 1,200,421. 29 Jul 1970. Priority date 20 Apr 1967, France.

A profile milling machine suitable for milling the inner surface of a tubular element, such as the graphite jacket for a nuclear reactor, along a generatrix is described. The machine includes a stand on which is mounted a support formed by two annular members adapted to receive and support a workpiece, a non-rotating hollow beam coaxial with the annular members, and a method for moving the beam axially relative to the annular members. A milling cutter is carried on the beam and has its rotational axis in a plane perpendicular to the beam axis. The cutter is connected to drive by a transmission disposed in the beam. An actuator is provided to displace the workpiece about its axis. (B.L.M.)

46411 APPARATUS FOR CONVERTING UO_3 TO UF_4. Delange, Maurice; Huet, Henri; Vertes, Paul (to Commissariat a l'Energie Atomique). U. S. Patent 3,518,060. 30 Jun 1970. Priority date 20 Apr 1960, France.

A first reactor for converting UO_3, by counter-current reaction with a reducing gas, to UO_2, is mounted above a second reactor for converting the UO_2, by counter-current reaction with HF gas, to UF_4. The bottom of the first reactor is connected to the top of the second reactor by cooled passage means which provide the only outlet for the gases issuing from the second reactor. Means responsive to the temperature of the UO_2 in the passage means are used in order to control means which in turn control the flow rate of the HF gas into the second reactor, to ensure elimination of the HF gas from the gaseous stream entering the first reactor. (auth)

Heat Transfer and Fluid Flow

Refer also to abstracts 46332, 46407, 46409, 46818, 47857, 47858, and 47915.

46412 (BNL-50183) TURBULENT LIQUID-METAL HEAT TRANSFER IN CONCENTRIC ANNULI WITH AXIALLY VARYING HEAT FLUX. TABULATIONS OF EIGENVALUES, EIGENFUNCTIONS, AND SERIES COEFFICIENTS. Yu, W. S.; Chen, John C. (Brookhaven National Lab., Upton, N. Y.). Mar 1969. 79p. Dep. CFSTI.

A solution for turbulent heat transfer in concentric annuli was recently derived and published. To utilize that solution to determine local Nusselt numbers for cases of axially varying heat flux, knowledge of the appropriate eigenvalues, eigenfunctions, and series coefficients is required. These characteristic constants were computed for 60 cases, covering the following ranges of parameters: Pr: 0.006, 0.005, 0.004 (Na at 400°F ≈ 1200°F); Re: 10^4, 5×10^4, 10^5, 5×10^5; and r_o/r_i: 1.2, 1.5, 2.0, 2.5, 3.0. Values of the first ten terms for the characteristic constants are presented. The governing equations and their solution are summarized and sample calculations are given to indicate how the characteristic constants can be used to determine local Nusselt numbers for any case of arbitrarily varying heat flux. (auth)

46413 (BNWL-1422) COBRA-IIA: A PROGRAM FOR THERMAL-HYDRAULIC ANALYSIS IN VERY LARGE BUNDLES OF FUEL PINS. Wheeler, C. L.; Main, G. C.; Kolesar, D. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 99p. Dep. CFSTI.

The digital computer program COBRA-IIA is described. This program is an extension of the COBRA II code written for rod bundle subchannel analysis involving steady-state single or two-phase flow. The basic method of calculation used in COBRA has been retained, with a finite difference solution obtained at each axial node. Typically, the volume the axial node approximates is the entire subchannel of incremental depth. An extensive set of refinements has been made to the COBRA II code to allow analysis of very much larger bundles of rods, with significantly less complex input and several model additions, including the effects of rotating spacer wires. Those features which differ from the COBRA II code are described in some detail. Program documentation and input instructions, as well as sample problems are provided. (auth)

46414 (CEA-R-3894) BOILING OF SUBCOOLED WATER IN FORCED CONVECTION. Ricque, Roger; Siboul, Roger (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1970. 69p. (In French). Dep. CFSTI (U. S. Sales Only).

An experimental study of heat transfer and pressure drop was made with the following conditions: local boiling in tubes of small diameters (2 and 4mm), high heat fluxes (about 1000 W/cm^2), high coolant velocities (up to 25 meters/sec), low outlet absolute pressures (a few atmospheres). Wall temperatures were determined with a good accuracy, as very thin tubes were used and heat losses were prevented. Two boiling phases were observed: the establishment phase and the established boiling phase. The inception of each phase is correlated. Considerable delays on boiling inception were also observed. The pressure drop was measured. If the axial temperature distribution of the fluid and the axial distributions of the wall temperatures, in other words the axial distribution of the heat transfer coefficients under boiling and non-boiling conditions, at the same heat flux or the same wall temperatures, are taken into account, then total pressure drop can be correlated but probably under certain limits of void fraction only. Using the same parameters, it seems possible to correlate the experimental values of critical heat flux obtained by A. E. Bergles. The very important effect of length and hydraulic diameter of the test sections is shown. (auth) (France)

46415 (EUR-4468) FORCED CONVECTION BURNOUT AND HYDRODYNAMIC INSTABILITY EXPERIMENTS FOR WATER AT HIGH PRESSURE. PART VI. BURNOUT HEAT FLUX MEASUREMENTS ON 9 ROD BUNDLES WITH LONGITUDINALLY AND TRANSVERSALLY UNIFORM HEAT GENERATION. Campanile, A.; Galimi, G.; Goffi, M.; Passavanti, G. (Societa Ricerche Impianti Nucleari, Saluggia (Italy). Centro Ricerche Nucleari). 27 Jan 1970. 46p. Dep. CFSTI (U. S. Sales Only).

Data on 235 burnout points obtained on a 3 × 3 square array of 10.2 mm OD Inconel tubes generating the same power with a uniform power distribution over a 1183 mm length are presented. The rod bundle was tested in two square channels having different flow area. Burnout was found to occur at locations in the lattice depending on the spacing between external rods and unheated surfaces as well as on physical test conditions. Whenever possible, measurements of the exit water temperatures and pressure drops were also taken. (auth)

46416 (GEAP-10196) DEFICIENT COOLING. Third Quarterly Progress Report, January 1-March 31, 1970. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr 1970. Contract AT(04-3)-189. 23p. Dep. CFSTI.

Design of nonuniform axial flux heaters, and equipment and piping design for simultaneous sampling of three subchannels in the nine-rod test section was completed and procurement initiated. Several one-rod transient flow tests were performed and results recorded on magnetic tape. This method is expected to result in more accurate and expeditious collection of transient data than the methods previously reported. The latter depends on processing data recorded on Sanborn charts and are considerably more laborious. Analog data are first reduced to a digital binary tape, and a computer program (GE635) written for converting the binary tape to engineering units. Procedural corrections are in progress. Two runs were made with the nine-rod test section in which flow and enthalpy were measured in the side subchannel. Typical reactor grid spacers were used with 18-inch spacing with the last spacer 4 inches from the flow exit where samples were taken. Flows were set at 0.5 and 1.0×10^6 lb/hr ft^2 and system pressure at 1000 psia. Comparison of this preliminary data, with previous data taken without spacers on Project Agreement 44, indicates the effect of the spacer is to increase flow in the corner and side subchannels and decrease flow in the center subchannel. This trend is in agreement with the distribution of spacer flow resistance in the three typical subchannels. (auth)

46417 (ORO-3936-1) THE VAPOR EXPLOSION: HEAT TRANSFER AND FRAGMENTATION. I. INTRODUCTION TO EXPLOSIVE VAPOR FORMATION. Bouvier, J. E.; Witte, L. C.; Cox, J. E. (Houston Univ., Tex. Dept. of Mechanical Engineering). Nov 1969. Contract AT(40-1)-3936. 27p. Dep. CFSTI.

Processes involved in reactions between high temperature materials and relatively cool liquids were examined. Illustrative incidents are described involving the metal, paper, and nuclear industries. The conclusion is drawn that both external and internal forces may contribute to the fragmentation of molten material. Research, both theoretical and experimental, is proceeding into both externally and internally produced fragmentation along with experiments on the mechanism of transition boiling over small particles. (J.R.D.)

46418 (TUBIK-18) STATIONARY HEAT TRANSFER IN INFINITELY LONG, ECCENTRICALLY LAYERED CYLINDERS WITH POSITION-DEPENDENT HEAT SOURCES AND PERIPHERAL RESTRICTIONS. Use of the Thermal Interpretation of Reactor Fuel Elements. Wolf, Lothar (Technische Universitaet, Berlin (West Germany). Institut fuer Kerntechnik). Apr 1970. 140p. (In German). Dep. CFSTI (U. S. Sales Only).

Stationary 2-dimensional transfer problems in thermally coupled multilayer cylindrical systems can be solved analytically even for deviations from ideal coaxial arrangements for boundary conditions of the third type; heat transfer coefficients can be either constant or surface-dependent, heat sources can be homogenous or inhomogeneous within the various layers. Two cases are distinguished; first, relative eccentricity of all layers is equal and, second, relative eccentricity varies. Mathematical procedures are different and are described. The two procedures are used to calculate surface temperature of fuel elements. For the first time, it is possible to solve important problems occurring at hot spots of fast breeder reactors. Because of their importance, carbide fuel elements are analyzed as to thermal behavior. The mathematical procedures are more complicated and time consuming than approximate procedures; however, they are far superior in accuracy. (H.B.G.)

46419 FORCED CONVECTIVE HEAT TRANSFER TO TURBULENT CO_2 IN THE SUPERCRITICAL REGION. Bourke, P. J.; Pulling, D. J.; Gill, L. E.; Denton, W. H. (Atomic Energy Research Establishment, Harwell, Eng.). Int. J. Heat Mass Transfer; 13: 1339-48(Aug 1970).

Measurements were made of the wall temperatures of a 4.56 m long, 2.28×10^{-2} m dia tube with heat transfer to turbulent flow of CO_2 at supercritical pressure. In some experiments the change in state of the CO_2 between the inlet and the outlet of the tube, covered the full supercritical range between the liquid and the gaseous phases and in others the effect of varying the inlet state through the supercritical region, was investigated. Measurements were made with both vertically upward and downward flow through the tube to determine the effect of changing the direction of the flow relative to bouyancy forces. A comprehensive set of data was obtained for pressures from 7.44×10^6 to 10.32×10^6 N/m^2, heat flux from 0.8×10^4 to 35×10^4 W/m^2 and mass flows from 0.127 to 0.695 kg/sec. Derivations of the local heat transfer from that for normal gaseous or liquid CO_2 ranged from factor of two deteriorations to order of magnitude improvements. (auth) (UK)

46420 INVESTIGATION INTO THE EFFECTS OF POLYMER MIXTURES IN ORGANIC HEAT CONDUCTORS ON THE SEDIMENTATION RATE ON A HEATING SURFACE. Bogdanov, F. F.; Polushkin, K. K.; Utkin, O. I.; Khoroshavin, V. D.; Shapovalov, R. G. This paper was summarized in At. Energ. (USSR); 26: 370(Apr 1969) as paper No. 273. (In Russian).

The results are given of an experimental study of the effect of various factors upon the rates of accumulation of sediment on heating surfaces. These include the percentage of polymers and ferric oxides in the organic heat carrier, and the roughness of the heating wall. Light petroleum which had finished its operating period in the first loop of the "Arbus" reactor was used as the heat carrier. Tubes of steel and aluminum (ϕ 6/1, l = 360 mm) and of aluminum alloys (ϕ 9/1, l = 360 mm) were used in the experiments. The steel and aluminum alloy tubes were all smooth whereas those of aluminum, some were smooth and others of different degrees of roughness, some being anodized. It was shown that the main cause of sediment formation on heating surfaces when using organic heat carriers is the high temperature of the heating wall, $t_{wall} > 350°C$. At lower temperatures, $t_{wall} = 315$ to 350°C, sediments accumulate only when there is boiling at the surface of the heating wall and when polymers are simultaneously added to the heat carrier; while the stronger the surface boiling and the more polymers in the heat carrier, the faster the sediments collect. In the absence of surface boiling, sediments do not collect on the heating surface even with a 27% concentration of polymers (as long as the temperature of the heating wall did not exceed t_{wall} 350°C). If there was no boiling at the heating surface and the temperature did not exceed 350°C then with light petroleum as the heat carrier, neither the thermal currents nor the polymers were a cause of sedimentation. It was shown that if surface boiling and polymers are present in the heat carrier (and if the temperature of the heating wall $t_{wall} > 320°C$), then the rates of sediment accumulation show a straight line dependence upon the magnitude of the thermal current. In the experiment it was established that the roughness of the heating surface has very little effect upon the rates of sediment accumulation. Thus, a fine surface with protuberances up to 0.1 mm increases the sedimentation rate somewhat, but one with protuberances larger than 0.2 mm decreases the rate. Ferric oxide mixtures in the heat carrier increase the sedimentation rates considerably; the sediments for $t_{wall} \leq 350°C$ appear flocculent and are partly washed away by the thermal current. The thin layer of flocculent sediment $\delta = 0.1$ mm does not have any noticeable effect on the convective heat exchange, i.e., upon the temperature drop in the wall layer. (auth)

46421 AXIAL STABILITY OF THE DRY PATCH FORMED IN DRYOUT OF A TWO-PHASE ANNULAR FLOW. McPherson, G. D. (Chalk River Nuclear Labs., Ont.). Int. J. Heat Mass Transfer; 13: 1133-52(Jul 1970).

Dryout is initiated by nucleation or thermocapillary forces in the liquid film which normally flows over the heated surface or by film which normally flows over the heated surface or by film starvation. Depending on the force balance at the upstream vertex or stagnation point of the dry patch, the patch may be quasi-stable or transient, growing upstream or rewetting. The forces considered are: thrust of the vapor leaving the film surface; stagnation or deceleration force on the film upstream of the stagnation point; surface tension in the neighborhood of the stagnation point; vapor shear at the film-vapor interface; hydrostatic head from the liquid film; drag at the small step in the film. The distance upstream of the dry patch boundary over which these forces are effective is divided into that distance over which the film is being decelerated and diverted with no change in thickness, and that distance over which evaporation reduces the thickness to zero. The following details are taken into account in the analysis: film velocity profile; reduction in the stagnation force due to the evaporative flow; temperature and heat flux distributions over the heater surface and across the film; film shape. The forces are evaluated for typical dryout conditions. Interpretation of the results suggests that for dry patch stability, the shear force must equal the surface force. Mechanisms are proposed whereby these forces can maintain a quasi-stable balance. Comparisons are made with a similar approach by other workers and some important differences are noted. (auth) (UK)

46422 HEAT TRANSFER TO MERCURY FLOWING IN-LINE THROUGH AN UNBAFFLED ROD BUNDLE: EFFECT OF ROD DISPLACEMENT ON LOCAL SURFACE TEMPERATURE AND LOCAL HEAT FLUX. Dwyer, O. E.; Hlavac, P. J.; Helfant, M. A. (Brookhaven National Lab., Upton, N. Y.). Nucl. Sci. Eng.; 41: 321-35(Sep 1970).

An experimental study of heat transfer to mercury flowing longitudinally through an unbaffled rod bundle was carried out. The purpose was to determine the effect of lateral displacement of a rod on local heat transfer behavior. In a previous paper, the effects of extent and direction of displacement on the rod-average heat transfer coefficient were presented for the displaced rod, on that (or those) toward which it was displaced, and on that (or those) from which it was displaced. Here, the effects of extent and direction of displacement on the peripherally local heating surface temperature, local heat flux, local heat transfer coefficient, and local surface temperature fluctuations are presented

for the displaced rod. The test bundle had a P/D ratio of 1.75, and the rods were special electrical heaters. It was found that rod displacement can cause a large circumferential variation in its local heat transfer characteristics. Aside from the P/D ratio, the independent parameters affecting these characteristics are circumferential angle (θ), relative cladding thickness $[(r_2 - r_1)/r_2]$, relative cladding conductivity (k_w/k_f), and flow rate (Pe). It was found that displacement of a rod can produce circumferential variations in its surface temperature comparable to the average temperature drop from the heating surface to the coolant stream. For a given displacement, this variation increases as average heat flux ($\bar{q}_2$) increases and as $(r_2 - r_1)/r_2$, k_w/k_f, and Pe decrease; changes in $\bar{q}_2$ have the greatest effect, and those in $(r_2 - r_1)/r_2$ and k_w/k_f, the least. For a given displacement and flow rate, the greater the surface temperature variation, the less will be the circumferential variation in the local heat flux. Thus, as either cladding thickness or conductivity increase, the variation in the local heat transfer coefficient (and therefore the average) remains about the same. It was found that, as a rod is displaced from its symmetrical position, the local heat transfer coefficients surprisingly decrease at all circumferential points, which partly explains why the rod-average heat transfer coefficient is highly adversely affected by lateral rod displacement. This is only true for liquid-metal coolants. (auth)

46423 TWO-PHASE CRITICAL DISCHARGE OF INITIALLY SATURATED OR SUBCOOLED LIQUID. Henry, Robert E. (Lewis Research Center, Cleveland). Nucl. Sci. Eng.; 41: 336-42(Sep 1970).

A nonequilibrium model is developed to describe the two-phase critical discharge of initially saturated and subcooled liquid through sharp edged inlet, constant area ducts with $L/D \geq 12$. A similar model is proposed for smooth inlet geometries with $L/D \geq 0$. The proposed solutions, which are based on the upstream stagnation conditions, exhibit excellent agreement with the published data which include water, Freon-11, and Freon-12 results. (auth)

46424 HEAT TRANSFER FROM PLASMA IN TUBE FLOW. Schmidt, P. S. (Univ. of Texas, Austin); Leppert, G. J. Heat Transfer; 92: 483-9(Aug 1970).

Heat transfer data are reported for partially ionized argon flowing in a water-cooled circular tube, ½ in. in dia. Experiments were run with initial mixed-mean temperatures up to 21,000°R at Reynolds numbers from 140 to 527 based on equilibrium properties evaluated at the entrance mixed-mean temperature. Measured plasma flow Nusselt numbers computed on an enthalpy basis correlate well with low-temperature, constant-property results after the first 5 to 10 diameters of the tube entrance region; closer to the entrance, Nusselt numbers were about 30% higher than constant-property entrance-region predictions. The tendency of the data to approach the constant property solution rapidly was predicted by a laminar finite-difference analysis for plasma flow published earlier. The analysis was modified for the present study to improve its accuracy. The finite-difference theory underpredicts the heat transfer in the first few tube diameters; two possible reasons for this discrepancy are the poor resolution in the inlet enthalpy profiles near the tube wall and nonequilibrium between electrons and heavy particles in this region. See also NSA 23: 523 for previous work. (auth)

46425 ELECTRON HEAT TRANSFER IN A QUIESCENT NONEQUILIBRIUM PLASMA. McAssey, E. V. Jr. (Villanova Univ., Pa.); Yeh, Hsuan. J. Heat Transfer; 92: 447-55(Aug 1970).

An asymptotic solution is obtained for the electron heat transfer to a spherical body immersed in a weakly ionized, quiescent plasma. Dimensional analysis of the governing equations shows that the problem can be divided into two regions: charge-separated and quasi-neutral. For the charge-separated region, the equations must be solved numerically, whereas the quasi-neutral solution can be expressed in closed form. From these studies it was found that the extent of the charge-separated region (i.e., sheath) is of the order of $\Lambda^{\frac{1}{5}}$. Within the sheath the effects of ionization and recombination are of the order of $\Lambda^{\frac{4}{5}}$. The results include the variation of electron flux, electron heat transfer, and current as a function of body potential. The results are presented in a form to permit the easy determination of the electron heat transfer to a body immersed in a quiescent, weakly ionized plasma over a wide range of operating conditions. Furthermore, the electrical characteristics presented here can be used in conjunction with electron-heating data to treat the body as a probe for diagnostic purposes. (auth)

Isotope Technology

Refer also to abstracts 46348, 46663, and 46818.

46426 (ALO-2617-1) TRANSIT RTG PROGRAM REPORT NUMBER 1. (TRW Systems, Redondo Beach, Calif.). 15 Jan 1970. Contract AT(29-2)-2617. 233p. Dep. CFSTI.

The selected radioisotope thermoelectric generator (RTG) conversion system configuration and support equipment are described. Results of other research are summarized on the RTG heat source, thermoelectric converter, heat source support structure, nuclear safety engineering, and support equipment. (J.R.D.)

46427 (CEA-CONF-1571) STUDY OF ION COLLISIONS USING AN ISOTOPE SEPARATOR WITH TWO MAGNETIC STAGES AND AN ELECTROSTATIC STAGE. Boge, Marc (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). May 1970. 4p. (In French). (CONF-700532-1). Dep. CFSTI (U. S. Sales Only).

From 4th Symposium on Atomic and Electronic Collisions, Brest, France.

The mode of operation of the Grenoble isotope separator is reviewed. The high temperature ion source (3000°C) is maintained at 50 kV and can deliver ion beams directly from the elements introduced. The principal causes of isotopic contamination were investigated in order to know the limits of enrichment of this separator and were found to be: the scattering of residual gas with subsequent neutralization (charge exchange); the dissociation of compound beams (e.g., NdO^+); the scattering of residual gas without charge exchange; and charge exchange occurring at the ion source exit. (auth) (France)

46428 (CEA-R-3999) STABILIZATION OF THE BEAM OF AN ISOTOPE SEPARATOR. Ristori, Christian (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1970. 15p. (In French). Dep. CFSTI (U. S. Sales Only).

Stabilizing devices which were constructed greatly reduce ion beam scattering in collector tanks of isotope separators. A 10^{-2} (in five minutes) variation in beam position is reduced to 10^{-5} (in half an hour) when the stabilizer is connected. A very low level amplifier of very high gain makes suitable stability obtainable even with very low intensity ion beams (10^{-9}A). (auth) (France)

46429 (CEA-R-4043) STUDY OF THE ISOTOPIC CONTAMINATION WITH THE TWO-STAGE GRENOBLE MAGNETIC SEPARATOR. Boge, Marc (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Aug 1970. 93p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Grenoble, Faculte des Sciences, France.

In order to know the limits of enrichment of the Grenoble electromagnetic isotope separator, the principal contaminations caused by ion scattering on the residual gas and by chromatism were studied. A second magnet was used with neodymium to analyze the ions ($Nd^+ \approx 500$ μA, $NdO^+ \approx 120$ μA, $Nd^{2+} \approx 70$ μA) which passed through the first stage slit. Therefore, the scattering with and without charge exchange of Nd^+ and the dissociation of NdO^+ were measured. The chromatism was studied by means of an electrostatic analyzer used as a third stage. The limits of enrichment were obtained for argon, uranium, and neodymium. (auth) (France)

46430 (JAERI-4051) RADIOISOTOPE PRODUCTION FROM FISSION PRODUCTS. A Literature Search. Amano, Hiroshi; Nakamura, Haruto; Kubota, Masumitsu; Takahashi, Satoko; Tachimori, Shoichi (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Nov 1969. 33p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

The following four subjects, related to radioisotope production from fission products, are included in this literature search. Methods for producing of ^{99m}Tc, ^{132}I, and ^{133}Xe; recent papers on fission products concerning methods of chemical separation are reviewed, and classified according to the kinds of nuclides and separation procedures; the behavior of ^{131}I, which is liable to cause air pollution with radioactive gas, is surveyed for the purpose of preventing the pollution; and an outline of the large scale production of long-lived radioisotopes from the waste of the fuel reprocessing is also reviewed. (auth)

46431 (MDC-G-1700) PLUTONIA/CURIA COMPATIBILITY TESTING. Quarterly Report No. 7, April-June 1970. Andelin, R. L.; Watrous, J. D. (McDonnell Douglas Astronautics Co., Richland, Wash. Donald W. Douglas Labs.). Jul 1970. Contract AT(45-1)-2138. 16p. Dep. CFSTI.

Continued comparative compatibility test results indicate that relatively pure plutonia-238 is less reactive with alloys of tungsten, rhenium, and molybdenum after exposure at 1800 and 2000°C than the original, less-pure plutonia. Improved compatibility is also exhibited by metallic specimens in contact with substoichiometric plutonia compared with stoichiometric PuO_2. More oxygen appears to have been lost by the purer form of plutonia through

container walls at 2000°C than was lost by the less-pure plutonia. Six refractory metal capsules containing curia-244 have completed exposure at 2000°C for 1000 hours. Two additional sets of six capsules are undergoing exposure, one at 1800 and one at 2000°C. Plutonia-molybdenum cermets tested at 1800 and 2000°C have completed 5000 hours exposure. (auth)

46432 (MMM-3691-62) DEEP SEA RADIOISOTOPE-FUELED THERMOELECTRIC GENERATOR POWER SUPPLY SYSTEM. SNAP-21 Program, Phase II. 10-Watt System; Final Summary Report. Fox, F.; Pannemann, R.; Wickenberg, R. (eds.) (Minnesota Mining and Mfg. Co., St. Paul. Electrical Products Group). May 1970. Contract AT(30-1)-3691. 389p. Dep. CFSTI.

The SNAP-21 system is a radioisotope-fueled thermoelectric generator designed for deep sea applications. It functions by converting the heat from a decaying radioisotope fuel into useful electric energy. This heat energy is converted into electric energy by a thermoelectric generator. Semiconductor-type thermoelectric materials, maintained in a temperature gradient, accomplish the conversion. The isotopic fuel supplies heat to the thermoelectric materials and sea water acts as the heat sink to maintain the temperature gradient. Other components are employed to increase efficiency and condition the electric output to the desired form. The components performing these functions are enclosed in a pressure vessel which protects them from sea water pressure and exposure. No external inputs are required to maintain operation of the system. With this type of mechanically-static, unsupported operation, long life with no maintenance is achieved. Data and descriptions are presented on components of SNAP-21 including the heat source, shielding, insulation, thermoelectric generator, power conditioner, pressure vessel, electric receptacle, and generator mounting. (J.R.D.)

46433 (NP-18428) AEROSPACE NUCLEAR SAFETY. A Bibliography of Selected Literature (1960-1968). Venchiarutti, Radames (Comitato Nazionale per l'Energia Nucleare, Rome (Italy). Divisione Affari Internazionali e Studi Economici). 1969. 326p. Dep. CFSTI (U. S. Sales Only).

A bibliography of 2985 references related to aerospace nuclear safety, covering the period from 1960 to 1968, is presented. The following number of references are given in each of the categories indicated: 252 on general safety; 276 on general radiation; 532 on isotope technology, auxiliary systems, and nuclear engineering; 286 on metallic and nonmetallic materials; 218 on corrosion and protective coatings; 92 on space vehicles and sciences; 61 on shield design; 26 on flight testing; 195 on geophysics and meteorology; 50 on research and support facilities; 166 on reentry; 54 on recovery; 131 on heat transfer and combustion thermodynamics; 55 on aerodynamics; 52 on trajectory and orbit mechanics; 120 on stresses, loads, and environmental testing; 109 on structural design and mechanics; and 110 on regulations and standards. (L.C.L.)

46434 (NUMEC-4189-2) RADIOISOTOPE-POWERED CARDIAC PACEMAKER PROGRAM. Phase II. Quarterly Progress Report. (Nuclear Materials and Equipment Corp., Apollo, Pa.). 28 Aug 1970. 45p. Dep. CFSTI.

Progress in the development of a radioisotope-powered cardiac pacemaker is reported and included: completion of the pilot production flow charts; analyses of electronic circuit problems; continued reliability and quality assurance testing; ultrasonic inspection of the inner capsule material (Ta-10W); thermal performance and life testing of the thermocouple tapes; and the initiation of cost reduction techniques for the processing of pacer components. (L.C.L.)

46435 (ORNL-4597) ORNL ISOTOPIC POWER FUELS QUARTERLY REPORT FOR PERIOD ENDING JUNE 30, 1970. Lamb, Eugene (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 26p. Dep. CFSTI.

The Curium Source Test continued to operate at a temperature of approximately 1300°C on the fuel capsule and at a vacuum of approximately 7×10^{-3} torr in the Primary Vacuum Chamber. The pressure and temperature of the helium reservoir were recorded for 67 days following assembly of the Curium Source to determine if the helium was being released quantitatively as the curium fuel decayed. Metallographic examination of two sets of $^{244}Cm_2O_3$ compatibility couples exposed for 10,000 hr at 1650 and 1850°C is complete. The effect of Gd_2O_3 on the phase change temperature of Cm_2O_3 is being studied. An adiabatic calorimeter is being assembled to measure the heat capacity of Cm_2O_3. Both nonradioactive and radioactive $SrTiO_3$ compatibility couples are being exposed at temperatures of 900 and 1100°C for various times. The thermal conductivity of a hot-pressed 2.48-g $^{90}Sr_2TiO_4$ pellet was measured. High-pressure tests and temperature aging tests have been made on thin-walled SNAP-23 capsules and on heavy-walled threaded cap SNAP-23 capsules. (auth)

46436 (ORNL-TM-3099) ISOTOPE KILOWATT PROGRAM. Quarterly Progress Report for Period Ending June 30, 1970. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 28p. Dep. CFSTI.

A heat block-shield design has been evolved that is suitable for all three power conversion systems under study. This unit has the further advantage that it can be used with either $SrTiO_3$ or SrF_2 fuel. A preliminary design for a reduced scale test loop to evaluate the thermal radiation stability characteristics of Dowtherm A has been prepared and is being reviewed critically. A conceptual design of a heat pipe test has been prepared, and preliminary arrangements for fabrication of a test unit have been initiated. The design and construction of a full-scale thermoelectric module has been discussed with 3-M and it has been concluded that the principal problems associated with integrating the junctions into a complete heat pipe module assembly are much the same for lead telluride and the more efficient advanced material under development. As a consequence, it appears that the next step after a test of a heat pipe tailored to this special application should be a test of a full scale thermoelectric module with lead telluride junctions. A firm proposal from 3-M to fabricate such a unit is expected early in the next quarter. (auth)

46437 (ZJE-80) EXPERIENCE IN THE MANUFACTURE OF NEUTRON SOURCE SEALED BY WELD. Kott, J.; Zbytovsky, A. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 9p. Dep. CFSTI (U. S. Sales Only).

A description is presented of the weld-sealed Ra-Be neutron source with an intensity of 10^7 n/sec. The 4π source was developed and manufactured in the Institute for Research, Production and Utilization of Radioisotopes in Prague and the Nuclear Power Plants Division of the ŠKODA Concern in Plzeň. Special emphasis is given to welding technology, equipment for transporting the source, and to the measurement of the source. (auth)

46438 COMPUTER PROGRAM FOR MAINTAINING RADIOACTIVE SOURCE INVENTORIES. Wegst, W. F.; Gallagher, E. E. (California Inst. of Tech., Pasadena). Health Phys.; 19: 444-8(Sep 1970).

A Fortran IV program is given and discussed which maintains a complete inventory of all radioactive sources used at the California Institute of Technology. The current inventory tabulations divide the 250 to 300 individual sources into three groups; sealed sources, unsealed sources, and sources stored in specifically designated storage pits. The program accounts for radioactive waste material removed from the campus and calculates radioactive decay on all sources, the activity of each radioisotope and the total activity of all the radioisotopes. (UK)

46439 RADIOISOTOPES FOR STUDIES AND IN THE MONITORING OF CHEMICAL PROCESSES. Schulze-Pillot, Gerhard (Farbwerke Hoechst AG, Frankfurt am Main). Neue Tech., B; 10: 201-9(1968). (In German).

The application of radioactive indicators for the study of chemical engineering problems is discussed (reactions, determination of contents and mixture degrees in reaction vessels, registration of residence time distribution and measuring of flow velocity in continually working reaction vessels) with a view to the choice of the adequate radioisotopes, the determination of possible measurement results and the necessary radiation protection to be taken. Furthermore, the application of closed radioactive sources in the field of operational control (level gages for liquids, density and thickness gages, and determination of C/H ratios) is discussed. (auth)

46440 URANIUM ENRICHMENT PRICING CRITERIA. HEARINGS BEFORE THE JOINT COMMITTEE ON ATOMIC ENERGY, CONGRESS OF THE UNITED STATES, NINETY-FIRST CONGRESS, SECOND SESSION, JUNE 16 AND 17, 1970. Washington, D. C.; Joint Committee on Atomic Energy (1970). 255p. GPO $1.00.

On June 16 and 17, 1970 the Joint Committee on Atomic Energy held hearings on the AEC proposed increase in the price of uranium enrichment services and new criteria for pricing. The statements of witnesses before the committee are reported verbatim. Press releases on the subject from the AEC, JCAE, Senator Gore, and the White House are included as well as correspondence and 11 appendixes of published information pertinent to the subject. (L.C.L.)

Materials Testing

Refer also to abstracts 46207, 46388, 46401, and 46714.

46441 (AERE-R-5792) THE MEASUREMENT OF SMALL DIMENSIONAL CHANGES BY NEUTRON RADIOGRAPHY. Progress Report. Matfield, R. S.; Constantine, G.; Alexander, S. C. (Atomic Energy Research Establishment, Harwell (England)). Jul 1969. 64p. Dep. CFSTI (U. S. Sales Only). UK 12s. 0d.

A general description of the theory and practice of neutron radiography, with special emphasis on the techniques suitable for use with radioactive materials, is given. The application of the transfer method, using a radioactive foil to produce an image on a photographic film, was studied and subsequently developed for the nondestructive measurement of the dimensional changes of samples within a radioactive in-pile experiment. The accuracy tentatively claimed is +0.001/−0.003 in., and further work is recommended since the technique used may be capable of further refinement. A few experiments were conducted with a boron foil and cellulose acetate film, and further work on alternative materials is suggested. The appendix gives comparative examples of x-radiographs and neutron radiographs to demonstrate the use of neutron radiography as an inspection technique. (auth)

46442 (BNWL-1468) EDDY CURRENT MULTIPARAMETER TEST FOR TUBE FLAWS IN SUPPORT REGIONS. Libby, H. L.; Wandling, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 25p. Dep. CFSTI.

Results of laboratory investigations showed that two-frequency multiparameter eddy current nondestructive testing offers a way to dramatically reduce interfering tube test signals caused by simulated tube supports made of stainless steel or mild steel. An analysis of complex plane data of the tube support signals and a signal caused by a suspected region of intergranular corrosion in a stainless steel tube confirms the discrimination which was observed experimentally. The test described appears to be a workable system which represents a compromise between full application of the multiparameter test principles with the resulting complexity of circuits and adjustments and a test system of reasonable complexity which may meet the needs of practical field problems. Further tests are needed using real tube supports to determine optimum operating conditions. (auth)

46443 (BNWL-SA-3054) THERMAL AND ULTRASONIC NONDESTRUCTIVE TESTING METHODS FOR CARBON-CARBON COMPOSITES. Green, D. R.; Dixon, N. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). May 1970. Contract AT(45-1)-1830. 50p. (CONF-700112-1). Dep. CFSTI.

From American Society of Mechanical Engineering Symposium, Albuquerque, N. Mex.

Thermal and mechanical properties are important factors in the performance of carbon-carbon composites. Flaws and property differences in composite parts can often be detected using ultrasonic and high-speed thermal methods recently developed at Battelle-Northwest (BNW). A feasibility study demonstrating the application of these methods to carbon-carbon composites was conducted. This study made use of a new thermal image transducer method, an infrared scanning method and a high-power broad-band ultrasonic method using special transducers. Both the thermal transducer and ultrasonic methods require dry contact with the test specimen, but no wet couplant or other preparation is necessary when the surface of the test specimen is reasonably smooth. The range of test specimens and types of defects that could be included in the study was limited by the cost and scarcity of material available for specimens. However, the methods were demonstrated for detection of delaminations, voids, cracks, porosity, differences in thermal properties, and differences in density. The ultrasonic method was also applied to measure the elastic and polar moduli. (auth)

46444 (RT/ING-(70)5) DUMOS: PROGRAM FOR CALCULATION OF FREE VIBRATIONS IN RECTILINEAR ELASTIC ELEMENTS. Dusi, G.; Mosiello, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 20 Feb 1970. 45p. (In Italian). Dep. CFSTI (U. S. Sales Only).

Aspects of free flexural undamped vibration are examined. A digital code was used to find natural frequencies and normal modes of transverse vibration of a straight continuous beam is described. General restraints can be considered, while mass distribution is allowed to change step by step. Where necessary, shear deflection and rotary inertia effects can be introduced. Up to nine modes of vibration can be plotted on a diagram. (auth)

46445 (UCRL-72582) ACOUSTIC EMISSION TECHNIQUES IN MATERIALS RESEARCH. Liptai, R. G.; Harris, D. O.; Engle, R. B.; Tatro, C. A. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Jul 1970. 97p. (CONF-700907-1). Dep. CFSTI.

From Symposium on Advanced Experimental Techniques in the Mechanics of Materials, San Antonio, Tex.

A review of the application of emission analysis to evaluate materials properties and defect structure is presented. Topics discussed include fracture toughness and crack propagation, fatigue, plastic deformation, and creep processes in metals, composites, and rock materials. The status of emission techniques as applied to the evaluation of structural integrity is reported. A complete discussion of experimental techniques and data acquisition and processing systems is given. It is concluded that acoustic emission techniques have wide applicability to experimental studies in materials research and to evaluation analysis of structural integrity. Directions of future developments and applications are discussed. (auth)

46446 (ZJE-82) RESEARCH ON STRENGTH AND RESISTANCE TO BRITTLE FRACTURE OF LARGE BODIES. Kaina, K. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 16p. Dep. CFSTI (U. S. Sales Only).

The determination of the strength and safety of large structures requires the testing of specimens with actual thickness and sufficient width and therefore requires a testing machine of high capacity. A brief description of the machine and the tests which can be made on it is given. Some of the most important results of the research work and the application of these results are presented. (auth)

46447 (ZJE-83) COMPARISON OF ULTRASONIC FINDING WITH ACTUAL DEFECTS. Prepechal, J. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 17p. Dep. CFSTI (U. S. Sales Only).

The relation between an ultrasonic indication obtained by ultrasonic inspection and the actual characteristics of defects is discussed. The precision and reliability of the inspection and the relation between the equivalent and actual area of a defect were investigated for the defects in a forging of Al-Mg-Si alloy. (auth)

46448 TECHNIQUES FOR TWO-DIMENSIONAL GAMMA-RAY SCANNING OF REACTOR FUEL ELEMENT SECTIONS. Barnes, B. K.; Holm, D. M.; Sanders, W. M.; Clinton, D. D.; Swansen, J. E. (Los Alamos Scientific Lab., N. Mex.). Nucl. Appl. Technol.; 9: 746-54(Nov 1970).

Two-dimensional gamma scanning has been developed to supplement linear gamma scanning and microsampling in determining the spatial distributions of radioactive isotopes in reactor fuel elements. The techniques used in the two-dimensional scanning are discussed. These include sample preparation, collimator design, spatial resolution, detector systems, data analysis, and data presentation. Examples of the type of results which can be expected from the techniques are given and future developments are discussed. (auth)

46449 NEUTRON SOURCES FOR NEUTRON RADIOGRAPHY. Cutforth, Darrell Claude. Logan, Utah; Utah State Univ. (1969). 146p.

Thesis.

The performance of potential neutron sources for neutron radiography was studied. Spatial and spectral neutron distributions were calculated for several source-moderator combinations. The calculative techniques were verified by comparing theoretical results with experimental results for selected systems. A small nuclear reactor is the best source for neutron radiography. A reactor has the highest available thermal-neutron flux, and both acquisition and operating costs per thermal nv are lower for a reactor than for either isotopic or accelerator sources. Results in the report demonstrate that for those applications where a reactor source cannot be used, either isotopic or accelerator sources can be substituted. However, because of a shortage of thermal neutrons, radiographs made with isotopes and accelerators will be inferior to radiographs made with a reactor. With the same degree of collimation, radiography beams from a small reactor would be at least three orders of magnitude more intense than beams from practical isotopic or accelerator systems. (Diss. Abstr. Int., B)

46450 AUTORADIOGRAPHY IN THE SCANNING ELECTRON MICROSCOPE. Paul, D. (Fibre Research Inst., Teltow-Seehof, Ger.); Groebe, A.; Zimmer, F. Nature (London); 227: 488-9 (1 Aug 1970).

It is stated that the results of electron microscope examination of the structure of solids often need to be supplemented by tracing the chemical processes leading to particular structural features. This can be achieved by using radioisotopes, the distribution of which in the specimen can be determined by autoradiography. Although the resolution of about 1000 Å in electron microscope autoradiography with T is much lower than that in common electron

microscope work, ultrastructure research has been aided by T autoradiography. The distribution of a T-labeled sizing auxiliary in a cellulose fibre is shown micrographically. A disadvantage, however, is the need to prepare ultrathin sections. In the studies described, this time-consuming preparation was overcome by evaluating the autoradiographs in the scanning electron microscope. The distribution of radioisotopes on the surfaces of large specimens could be determined by coating the surface with a compact layer of a film emulsion. Gold vapour was also deposited to give a 150-Å layer on the specimen to dissipate static electricity. The stereo autoradiograph obtained for a tritiated auxiliary on a cellulose fibre is shown micrographically. It was concluded that application of the autoradiographic technique, combined with scanning electron microscopy, provides advantages in examining biological, metallurgical, and similar solids. (UK)

46451 APPARATUS AND SHUTTER FOR USE IN RADIOGRAPHY. Jansen, Jean-Charles (to European Atomic Energy Community). British Patent 1,200,743. 29 Jul 1970. Priority date 15 Dec 1966, Belgium.

An orientatable-slit moving shutter for the radiography of objects is proposed for elimination of fog due to emission by the object. The apparatus includes means for producing a beam of penetrating radiation and a shutter opaque to the radiation movable across the beam. The shutter has at least one slit-like passageway through it. The passageway is elongated in the direction of the beam and movable within the shutter to maintain the passageway aligned with the beam during movements of the shutter across the beam. (B.L.M.)

46452 RESEARCH TECHNIQUES IN NON-DESTRUCTIVE TESTING. Sharpe, R. S. London; Academic Press (1970). 492p. Pound 8.

Sections are included on the following topics: acoustic emission; ultrasonic spectroscopy; ultrasound imaging systems; ultrasonic critical angle reflectivity; ultrasonic holography; optical holography and coherent light techniques; data handling techniques; direct view radiological systems; neutron radiography; a communication network approach to sub-millimetric wave techniques in nondestructive testing; multiparameter eddy current concepts; pulsed eddy current; microwave techniques; and infra-red techniques. An interesting application of acoustic emission described is for the continuous surveillance of nuclear reactor components to detect and locate flaws. (UK)

Protective Structures

46453 ESTIMATION TECHNIQUES FOR FAR-FIELD EXPOSURE CONTRIBUTIONS. Reynolds, R. S.; Eckhoff, N. D. (Kansas State Univ., Manhattan). Nucl. Appl. Technol.; 9: 762-6(Nov 1970).

The model using two structure attenuation coefficients was used to estimate the far field exposure contribution for an experimental house. Restricted least squares and minimum absolute deviation (MAD) techniques were used to make these far field exposure contribution estimates. The latter two methods yielded results which were superior to the usual unrestricted least squares technique. The far field contribution was always positive and all coefficients were positive but less than unity. (auth)

Radioactive Material Handling

Refer also to abstracts 46190, 46295, 46298, 46318, 46395, and 46397.

46454 (ARH-SA-64) TREATMENT AND STORAGE OF HANFORD'S HIGH SALT, INTERMEDIATE-LEVEL, LIQUID WASTES. Ritter, G. L.; Tomlinson, R. E. (Atlantic Richfield Hanford Co., Richland, Wash.). 31 Jul 1970. Contract AT(45-1)-2130. 12p. (SM-137/49; CONF-700905-3). Dep. CFSTI.

From Symposium on Developments in the Management of Low and Intermediate Level Radioactive Wastes, Aix-en-Provence, France.

Factors affecting selection of in-tank waste solidification process at Hanford are discussed. The three phases involved in creating and storing the waste salt cakes, and preliminary conclusions regarding the safety of the in-tank approach for long-term storage of the wastes are also examined. Results of data analysis indicate that as long as surveillance is maintained, the storage of salt cakes in tanks at Hanford is safe. (J.R.D.)

46455 (ARH-SA-65) LAND REQUIREMENTS AND WASTE MANAGEMENT POLICY AT HANFORD. Brown, D. J.; Warren, J. H. (Atlantic Richfield Hanford Co., Richland, Wash.). [1967]. 14p. (SM-137/48; CONF-700905-1). Dep. CFSTI.

From Symposium on Developments in the Management of Low and Intermediate Level Radioactive Wastes, Aix-en-Provence, France.

Results of a study related to evaluation of land requirements for disposal of waste at Hanford are presented. It appears that the Hanford Reservation is situated in a uniquely favorable position with respect to the climate, topography, population density, and types of underlying sediments. Conditions at this site have proved to be favorable for the disposal of both solid and liquid wastes to the ground. Experience has shown that this practice is safe and that the amount of land required to carry on these operations and practices can be reduced. Studies show that while some land could be made available for other use, some restrictions might be required to preserve the favorable natural environment at this nuclear plant site where radioactive wastes are stored in the ground pending a national decision regarding ultimate disposal of this material. (J.R.D.)

46456 (CEA-R-3982) SOLIDIFICATION OF RADIOACTIVE WASTES WITH BITUMEN. Rodier, Jean; Rodi, Lucienne; Lefillatre, Guy; Cudel, Yvonne (Commissariat a l'Energie Atomique, Chuscian (France). Centre de Production de Plutonium de Marcoule). Aug 1970. 129p. (In French). Dep. CFSTI (U. S. Sales Only).

The storage of liquid or solid radioactive waste products presents some safety problems from the point of view of contamination and dispersion. The processing of these waste products was therefore widely studied in the various countries. Among the possible solutions, the use of bitumen for waste solidification attracts most attention; the interest in this process can be seen from the number of articles published on the subject, the most important of which comes from Belgium, France, U.S.A., U.S.S.R., Great Britain, German Federal Republic, or other countries such as Japan, India, Pakistan and the U.A.R. From an analysis of documents published to 1970, details are available about the various types of bitumen used, the nature of the waste which is processed, lixiviation of the radioactive matter, the results of research, the description of pilot installations of industrial plants, the problems arising from the use of bitumen, the risks arising from the solidification with the bitumen, due to both the coating process and to the storage, and finally the prospects concerning the development of the bitumen solidification process. From an estimate of the cost, a comparison with the other processes was possible. A critical, comparative study enabling valid conclusions to be drawn was made. (auth) (France)

46457 (NLCO-1075) DISPOSAL OF LOW-LEVEL RADIOACTIVE WASTES FROM PILOT PLANT OPERATIONS. Boback, M. W.; Davis, J. O.; Ross, K. N.; Stevenson, J. B. (National Lead Co. of Ohio, Cincinnati). 7 Jul 1970. Contract AT(30-1)-1156. 22p. (CONF-700818-1). Dep. CFSTI.

From 3rd Joint Meeting of the American Institute of Chemical Engineers and the Mexican Institute of Chemical Engineers, Denver, Colo.

Pilot Plant operations at the National Lead Company of Ohio include the solvent extraction of thorium, the testing of new methods for thorium metal production, and various operations with uranium materials. Most liquid wastes from these operations are given local treatment and then sent to a central facility for additional treatment. Neutralized wastes with no scrap value are then sent to a settling basin. Clear effluent from the basin is discharged to the Great Miami River. Residues from acid-digestion processes may be drummed for later uranium or thorium recovery. Most solid waste is sent to on-site disposal pits; however, certain thorium residues are drummed for disposal at an off-site commercial burial ground. (auth)

46458 (STI/DOC-10/116) BITUMINIZATION OF RADIOACTIVE WASTES. Review of the Present State of the Development and Industrial Application. (International Atomic Energy Agency, Vienna (Austria)). 1970. 137p. IAEA $4.00.

A review of the present state of the development and industrial application in many countries of methods for incorporating radioactive wastes in bitumen is presented. Topics discussed include: properties of bitumen; types of waste suitable for incorporation into bitumen; radiation effects; additives for product management; effects of nitrate content in waste on physicochemical properties of the final products; emulsifying agents; heat transfer in bitumen-sludge mixtures; off-gas cleaning; mixtures and their properties; operational techniques; disposal of bituminous products; the economic and safety aspects of bituminization processes; and a description of the individual status of current research on bituminization processes being conducted in eleven countries. (L.C.L.)

46459 (TID-25510) QUALIFICATION OF UMPIRE LABORATORIES FOR THE ANALYSIS OF URANIUM AND PLUTONIUM MATERIALS. REPORT IX. SECOND REPORT ON URANYL NITRATE. Tingey, F. H.; Balkovetz, F. J.; Lund, D. M.; Musgrave, B. C.; Spraktes, F. W.; Yamamura, S. S. (Idaho Nuclear Corp., Idaho Falls). Jul 1970. Contract AT(10-1)-1230. 8p. Dep. CFSTI.

A program was undertaken to determine the qualifications of U. S. commercial and foreign laboratories to serve as umpires in AEC transactions involving plutonium and uranium materials. The initial report on the precision and accuracy of uranyl nitrate tests done in qualified laboratories was published in 1968. Since then, two more laboratories have submitted results which were statistically evaluated in the same manner as those previously reported. Tabulated data which summarize the results of the precision and accuracy tests on all data submitted by July 1970 are presented. (L.C.L.)

46460 ALPHEUS: THE ACTIVE-WASTE PLANT FOR THE INSTITUTE OF ATOMIC PHYSICS, BUCHAREST. Bray, P. J.; Jerkins, E. (Fairey Engineering Ltd., Stockport, Eng.). Neue Tech., B; 11: 225-7(1969).

Descriptions of the Alpheus Plant and methods to be used in processing active waste at this installation are presented. Design of decontamination routes is described along with methods to be used for ash, solid waste, and compressible waste. (J.R.D.)

46461 WASTE MANAGEMENT AT EUROCHEMIC. Thorstensen, S.; Lopex-Menchero, E. Neue Tech., B; 11: 20-8(1969).

Evaluation of experience at Eurochemic is the basis for conclusion that it is possible to operate a fuel processing plant in a densely populated area by imposing strict discharge limitations. The plant capacity can safely be increased to at least 1 ton/day without exceeding discharge limitations. The additional expense of treating the lower-active solid and liquid wastes, including perpetual care of resulting sludges, amounts to approximately $0.5/kg U processed. This will be even lower if the plant capacity is increased. The costs for perpetual care of decladding waste are very high, irrespective of site location, when compared with all the other expenses in waste management. (J.R.D.)

46462 CONCEPTION AND CONSTRUCTION OF THE EUROCHEMIC REPROCESSING PLANT. Detilleux, E.; Barendregt, T. J. Neue Tech., B; 11: 5-14(1969).

Design and construction of the Eurochemic reprocessing plant are described. Information is included on fuel processing capabilities, characteristics of the chemical processes, processing flowsheets, design of main processing equipment, control equipment, and instrumentation. (J.R.D.)

46463 REPROCESSING AS PART OF THE FUEL CYCLE. Leclercq-Aubreton, M. Y.; Rometsch, R. Neue Tech., B; 11: 42-8(1969).

The various steps in the fuel cycle and their possible performance in Europe are examined. Two major steps in the nuclear fuel cycle, namely enrichment and reprocessing, require an extended, assured market in the European market for the next 10 to 15 years for profitable industrial exploitation. The other fuel cycle activities are already or will soon become business propositions with normal profits. The estimated growth rates make them appear more valuable, but profit can be realized only when the key operations, enrichment and reprocessing follow. These two fuel cycle activities should therefore logically be established as joint ventures by the European nuclear industry. First steps in his direction have been made and there is good hope that vertical integration of all fuel cycle activities based on industrial initiative and European cooperation will become reality in a few years. (J.R.D.)

Vacuum Engineering

46464 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 5, NO. 6, 1970. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 63p.

An index of the literature of the latest results of surface and vacuum physics research is presented. The bibliographic part contains key words or key word combinations to indicate subject matter in the articles. Both the bibliography and the indexes are prepared by computer. (J.R.D.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstracts 46387, 47722, and 47891.

General Detectors and Monitors

Refer also to abstracts 46178, 46516, 46524, 47563, 47628, and 47655.

46465 (CEA-N-1334) TIME TO PULSE HEIGHT CONVERTER WITH TIMING COMPENSATION FOR P-I-N DETECTORS. Van Zurk, R.; Mougin, A. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Jun 1970. 30p. (In French). Dep. CFSTI (U. S. Sales Only).

A time to pulse height converter designed to be used with p-i-n detectors was described. The leading edge timing walk, due to rise time variations of the stop pulses, was compensated by a system using a linear extrapolation method. The different factors which affect the time resolution are examined, and some experimental results in an energy range from 250 keV to 2.75 MeV are given. (France)

46466 (CEA-N-1353) PROTECTION OF PULSE MEASURING EQUIPMENT AGAINST SPURIOUS NOISES. Buisson, J.; Garau, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1970. 14p. (In French). Dep. CFSTI (U. S. Sales Only).

The correct functioning of neutron pulse measuring equipment in noisy environments is very dependent upon the technology of the connecting materials and the precautions taken in making the connections. The general rules applying to the liaison of the detector and the electronic subassembly are stated. The type of liaison giving the best protection against spurious noises is given. The technology recommended for different parts of this liaison (detectors, connectors cables, etc.) is discussed. The types of materials to be used with the pulse measuring subassemblies of the standard Multibloc type are reviewed. (France)

46467 (CEA-R-3967) STUDY OF THE LIGHT EMITTED BY ELECTRON AVALANCHES IN BINARY MIXTURES CONTAINING MOSTLY XENON. Morucci, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1970. 131p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Univ. of Paris, Faculte des Sciences, Orsay, France.

A coincidence between the simultaneous electric information received from electrons of an avalanche head and the light information received by a photomultiplier located at the output slit of a grating monochromator was made. In this way a recording was obtained which varied according to the light emitted by an avalanche in the binary mixtures of xenon and organic vapor (total pressure: one atmosphere). A continuum occurred in the case of every mixture and a xenon spectrum, which became less dominant when the vapors added were of low ionization potentials, was identified. A theory on the visible continuum of xenon, by direct electron-xenon molecule interaction is proposed. This is supported by an experiment in which there was a substantial increase in the visible light output, in the absence of the excited xenon states (Xe^*5p^56s). (France)

46468 (EGG-1183-2230) SUPPORT ACTIVITIES FOR CALIBRATION OF HIGH-INTENSITY FLASH X-RAY MACHINES. S-479-R. Stevens, J.; Beers, R. H.; Contreras, I. D. (EG and G, Inc., Santa Barbara, Calif.). Jun 1970. Contract AT(29-1)-1183. 47p. Dep. CFSTI.

For Sandia Corp., Albuquerque, N. Mex.

The work performed in support of a program to characterize the output of the Sandia Corporation's high-intensity flash x-ray machines is described. A Compton magnetic spectrometer, used to measure the bremsstrahlung spectrum, is described; and a three-element Compton diode (ratio detector) designed, fabricated, and calibrated for use in measuring the instantaneous energy of the electrons producing the bremsstrahlung, is discussed. (auth)

46469 (FEI-178) OPERATION OF A COUNTER FILLED WITH ^{3}He IN VARIABLE HIGH-INTENSITY GAMMA FIELDS. Bogatyrev, V. K.; Frolov, V. V.; Dubovskii, B. G.; Charychanskii, V. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1969. 27p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Data on the registration of neutrons against a strong background of gamma-radiation, with the use of counters filled with ^{3}He, are presented. It is shown that a counter operating under conditions of high gas-amplification is not effective in gamma fields exceeding 10 roentgens per hour. Factors affecting the insensitivity of the SNM-18 counter filled with ^{3}He up to 4 atmospheres pressure, to gamma-radiation, are discussed. (auth)

46470 (LNF-70/31) USE OF TRANS-STILBENE CRYSTAL TO MEASURE THE EQUIVALENT DOSE IN A MIXED γ-n FIELD. Note No. 483. Bardina, R.; Ladu, M.; Pelliccioni, M.; Roccella, M. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 6 Jul 1970. 12 p. Dep. CFSTI (U. S. Sales Only).

The possibility of using a trans-stilbene crystal to measure the equivalent dose in a mixed γ-n field has been studied. We have obtained γ-ray and neutron signals, separated by pulse shape discrimination, with a good equivalent dose response. For the neutrons, a good equivalent dose response was obtained in the range of 0.1 to 10 MeV (where the elastic scattering is predominant) by suitable saturation of the pulses produced by recoil protons. For the γ-rays, the absorbed dose was measured in the scintillator because of its tissue equivalence up to several MeV. In the range of γ-ray exposure up to about 0.2 R/hr, the sum of the two measured contributions was constant, within the experimental errors, when the relative dose intensity was varied, keeping fixed the total equivalent dose rate. (auth)

46471 (LYCEN-7023) THEORETICAL AND EXPERIMENTAL STUDIES ON THE TIME RESOLUTION OF Ge(Li) DETECTORS. Balland, Jean-Claude (Lyon Univ. (France). Institut de Physique Nucleaire). Apr 1970. 93p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

The problem of the extraction of the temporal information contained in a signal from a Ge(Li) junction was studied. A statistical estimation method was used, which allowed the lower limit of the variance of the estimated signal arrival time to be defined. The statistical properties of the detector electronic system were then studied. It was possible to simulate experiments which were very difficult or impossible to perform in practice; in particular the influence of several filters on the performance of the system was investigated. The electronic system and the results attainable are described. (France)

46472 (NP-18404) RADON DETECTION IN THE SEA AND THE ATMOSPHERE. Delos, Yvan (Toulouse Univ. (France). Faculte des Sciences). Jun 1970. 104p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis.

An apparatus for the measurement of low quantities of ^{222}Rn in air, or in water, using the adsorption on activated carbon was developed. Two precise problems were investigated with the apparatus. On one hand, the aircraft measurement of ^{222}Rn was made. This method allows freedom of the equilibrium state between Rn and its daughters. On another hand, the measurement of Rn dissolved in sea water, for studying the Rn flow at sea-air interface, was made. Measurements made in the Mediterranean Sea along the coasts showed that the Rn profiles were very variable, and related to the motions of water. (France)

46473 (UUIP-679) COMPUTER METHOD FOR THE EVALUATION OF THE OPTICAL PROPERTIES OF SCINTILLATION DETECTOR ASSEMBLIES. Falk, F.; Sparrman, P. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1970. 20p. Dep. CFSTI (U. S. Sales Only).

A computer program for the evaluation of the influence of optical parameters on the properties of scintillation detectors (scintillator and light guide) is described. The detectors considered were cylindrically symmetric, as e.g., used in lens spectrometers for electrons. The results of the calculations made for fourteen differently designed scintillator and light guide assemblies indicate that the geometrical design and the reflective coating of the scintillator have predominant influences on the performance of the assembly. (auth) (Sweden)

46474 (UUIP-710) INFLUENCE OF TRAPPING ON THE CURRENT PULSE IN SILICON DETECTORS SHOWING PLASMA EFFECTS. Seibt, W.; Sundstroem, K. E.; Tove, P. A. (Uppsala Univ. (Sweden). Inst. of Physics). May 1970. 13p. Dep. CFSTI (U. S. Sales Only).

Current pulse shapes in silicon detectors for strongly ionizing particles giving plasma effects are presented and discussed. It is shown that under certain circumstances trapping and detrapping occur which give a tail in the current pulse. Complementary views, relative to a previous report, are given concerning the rise time of the pulse. (auth) (Sweden)

46475 (UUIP-711) CHARGE COLLECTION IN SILICON DETECTORS FOR STRONGLY IONIZING PARTICLES. Seibt, W.; Sundstroem, K. E.; Tove, P. A. (Uppsala Univ. (Sweden). Inst. of Physics). May 1970. 19p. Dep. CFSTI (U. S. Sales Only).

A simple experimental and theoretical approach was developed for treating the charge collection in semiconductor detectors when dE/dx is so high that plasma effects should be expected to occur. The experiment was evaluated simply by measuring the 10 to 90% charge collection time t_c. The theoretical approach involves assumption of a constant spreading velocity for the charges in the polarized part of the plasma. From this the formula $t_c = \text{const.} [Ew/\mu F(F \pm F_0)]^{\frac{1}{2}}$ was obtained. This expresses the collection time in terms of the particle energy E, detector depletion width w, field strength F at the track, a constant field F_0 given by detector parameters and the mobility μ. Good agreement between theory and experiments was found over a wide range of energies and for different particles and detectors. (auth) (Sweden)

46476 Ge(Li) SPECTROMETER WITH A THERMOELECTRIC REFRIGERATING SYSTEM. Arsent'ev, I. N.; Dneprovskii, I. S.; Popeko, L. A.; Samoilov, P. S. At. Energ. (USSR); 28: 165-8 (Feb 1970). (In Russian).

The widely used Ge(Li) detectors must be used at 77°K, the temperature of liquid nitrogen. It was considered, therefore, of great interest to establish the conditions for carrying out spectrometric measurements with this material while cooling it by means of a Peltier (type) refrigerating unit. The properties of this detector studied at relatively high temperature, corresponded to cooling by thermal electric batteries. The detecting unit used consisted of a vacuum chamber which contained the detector together with a four-cascade battery. The cold surface of each cascade absorbed the heat of the neighboring unit below it; they contained 12, 30, 96 and 300 thermocouples. Cascades and their component element formed an electric circuit. The volt-ampere characteristics of the detectors had a saturated character within the 77 to 220°K range and at 500 to 1000 V. Even at a temperature of 211°K the energy resolution of the Ge(Li) detectors was found to be better than that of the best NaI(Tl) crystals of average size. At 180°K, the resolution of the new detector was about 10 times better than that of the scintillation type detectors. It is expected that elimination of the need for cooling with liquid nitrogen, the new Ge(Li) detector will be widely used for field investigations of γ radiation. (TTT)

46477 PARAMETERS OF ZnS(Ag)-BASED SCINTILLATORS FOR RECORDING NEUTRONS. Sokolova, Z. Ya.; Chernyaev, V. B. At. Energ. (USSR); 28: 162-4(Feb 1970). (In Russian).

Scintillators consisting of ZnS(Ag) and other compounds possessing high cross sections of interaction for slow neutrons, are widely used for recording neutrons. Parameters of several such materials were measured and compared. The recording efficiency of the scintillators was determined on the basis of the level of neutron absorption, portion of the energy of nuclear reaction products transferred to the zinc sulfate, light yield, and the photon yield coefficient. In the case of mixtures of ^{10}B and ^{6}Li, the absorption probability P of the neutrons by the scintillators depends on the ratio of the two isotopes as to slow neutron absorption coefficient of ^{10}B is four times higher than that of ^{6}Li. The value of P is also affected by the thickness l of the scintillator layer but l is limited by the low transparency of ZnS(Ag). The recording efficiency of detectors with various scintillators was determined at discrimination levels corresponding to a count of 0.1 pulse/sec from a 100 μ R/sec ^{60}Co γ source. The tabulated values allow to select the best suited scintillator for a given experiment. (TTT)

46478 STUDY OF TRI-α-NAPHTHYLBORON USED AS A SOLUTE IN ORGANIC SCINTILLATORS. Casas, L. H.; Heisel, F. (Centre de Recherches Nucleaires, Strasbourg). Int. J. Appl. Radiat. Isotop.; 21: 415-20(Jul 1970). (In French).

The spectral characteristics of tri-α-naphthylboron and the properties of liquid and plastic scintillators containing this substance as a fluorescent solute were examined. The transfer of excitation energy from the solvent (benzene or polystyrene) to tri-α-naphtylboron and the influence of the solute concentration on the scintillation efficiency of plastic detectors were investigated. (auth) (UK)

46479 VARIATIONS IN THE EFFICIENCY OF COPPER-WALLED, CO_2-FILLED PROPORTIONAL COUNTERS. Alessio, M.; Bella, F.; Improta, S. (Univ., Rome). Nuovo Cim.; 68B: 175-88(11 Aug 1970).

In copper-walled, CO_2-filled proportional counters, a systematic decrease in the counting rate was observed. The results of measurements are reported which show that the decrease observed is due (1) to the production of CO molecules, (2) to the emission of halogen molecules inside the counters. A quantitative interpretation of the decrease observed is also given. (auth)

46480 MEASUREMENT OF PLUTONIUM IN VIVO. Boulay, Pierre. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.); No. 79-80, 46-8(Sep-Dec 1969). (In French).

In the measurement of plutonium in vivo at least three conditions are necessary: a detector with a sufficient useful surface and a high sensitivity for the energy between 10 and 22.5 keV; to reduce to the maximum the background of the detector with respect to the low counting rate; and to calibrate the installation by taking into consideration the morphological factor of the patients. Each of these points is examined in some detail. The Morucci proportional detector designed for in vivo detection of plutonium traces in the lungs is now available commercially and appears to offer the most advantages, especially if it is filled with a xenon-methane mixture. The calibration of an installation consisting of such a detector is described. (J.S.R.)

46481 CURRENT POSITION OF LIQUID SCINTILLATORS IN RADIOACTIVITY MEASUREMENTS. Kowalski, E. (Landis and Gyr AG, Zug, Switzerland). Neue Tech., B; 10: 191-200(1968). (In German).

Apart from the purely physical properties such as the absolute photon yield or the fluorescence decay time, several other characteristics such as the solubility, quenching properties or the availability of a fluorescent compound, play an important role in the selection of a solute for liquid scintillators. The measurable parameters and their interdependence are discussed in general with emphasis on those scintillators which are used for practical measurements. (auth)

46482 MARK III SCANNER: A COMPACT DEVICE FOR MULTIPLE-VIEW AND SECTION SCANNING OF THE BRAIN. Kuhl, David E.; Edwards, Roy Q. (Univ. of Pennsylvania, Philadelphia). Contract AT(30-1)-3175. Radiology; 96: 563-70(Sep 1970).

A device for rectilinear and transverse-section scanning of the brain using ^{99m}Tc pertechnetate is presented. The scanner has four detectors to view four different aspects of the brain simultaneously. A self-contained computer controls display and all automatic operations with no processing delay. This system permits more thorough studies with multiple rectilinear and transverse section views without moving the patient, precise orientation of views to each other and to the patient's position, minimal technician operations to assure simplicity and reliability, maximum physician operation to assure a complete examination, efficient transfer of information, and economy of design to encourage wide application. (auth)

46483 SOME CHARACTERISTICS OF THE IFA EN3 NUCLEAR EMULSION. Nicolae, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 455-64(1970).

The main characteristics of the IFA EN3 emulsion, sensitive to electrons, are presented, namely: the mean grain size, the elementary composition, the sensitivity to relativistic particles, the reproducibility and the conservability. A value of 24.0 ± 0.5 grains/100 μm was found for the sensitivity to relativistic particles, and the emulsion fog was generally comprised between 1 and 2 grains/1000 μm^3. It is shown that the reproducibility and the conservability of this emulsion are very good. In view of an application to quantitative autoradiography, the average energy necessary to make developable an emulsion grain was established. For electrons having the average energy of 0.29 MeV (Tl^{204} — E_β max = 0.765 MeV) the value of 419 ± 40 eV/grain was found. (auth)

46484 NEUTRON DETECTION SYSTEM FOR OPERATION IN VERY HIGH GAMMA FIELDS. Roux, D. P. (Oak Ridge National Lab., Tenn.); De Lorenzo, J. T.; Ricker, C. W. Nucl. Appl. Technol.; 9: 736-43(Nov 1970).

A neutron detection system was evaluated for its gamma discrimination capability in gamma fields up to 10^7 r/hr. The fission chamber proved successful in these tests and was able to discriminate against a 10^7 r/hr gamma field with less than 50% loss in relative neutron sensitivity. (auth)

46485 EVALUATION OF A NEUTRON DETECTION SYSTEM IN A ^{60}Co FIELD OF 10^7 R/h. Buhl, A. R.; Ackermann, N. J. Jr.; De Lorenzo, J. T. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 744-5(Nov 1970).

In the presence of high gamma fields (10^6–10^7 r/hr), the neutron sensitivity of a fission counter is drastically reduced because of gamma pulse pile up in the counter and in its associated preamplifier, thereby limiting the effective application of measurement techniques such as reactor neutron noise analysis in situations where gamma intensities of $\geq 10^6$ r/hr are encountered. To overcome this limitation a detector-preamplifier system with current-mode signal processing was developed. The detector, which contains electrode plates coated with enriched uranium, has a neutron

sensitivity of 0.56 count sec^{-1} nv^{-1}. It is connected with 40 ft of cable to a low-noise preamplifier. This detector is designed to reduce alpha pulse pile up and gamma sensitivity and to have a fast charge-collection time. Current-mode signal processing required the development of a low-noise preamplifier. Measurements made with the system in gamma fields of 5×10^6 and 1×10^7 r/hr showed a neutron-sensitivity loss of 17 and 34%, respectively. (auth)

46486 FISSION-CHAMBER RADIATORS FROM A THREE-COMPONENT ISOTOPIC MIXTURE. Shchetinin, O. I.; Dmitriev, A. V.; Malyshev, E. K. At. Energ. (USSR); 28: 164-5(Feb 1970). (In Russian).

Steady-state measurement of the thermal neutron fluxes in the 10^{14} to 10^{15} n/cm^2 range requires a detector, the sensitivity of which is not affected by the burnup of the sensitive material. W. Bunche has proposed to use ternary mixtures of deficient isotopes of ^{234}U, ^{240}Pu, and ^{241}Pu. A more convenient mixture of ^{235}U, ^{232}Th, and ^{238}U is proposed on the basis of an equation which defines the sensitivity of the radiator. The neutron spectrum was characterized by the neutron temperature T_n and the epithermal parameter F_1. For the calculations T_n was taken to be 300°C, using values of 0.000, 0.010 and 0.020 for F_1. The time of irradiation was assumed to be 1 year and the neutron flux was taken as 1×10^{15} n/cm^2. sec. For $F_1 = 0.010$, the best sensitivity was obtained for a ^{235}U : ^{232}Th : ^{238}U ratio of 1 : 48 : 22. This mixture was carefully tested in various fission chambers. (TTT)

46487 EFFICIENCY OF A WHOLE-BODY COUNTER WITH INHOMOGENEOUS DISTRIBUTION OF THE ISOTOPE IN THE SOURCE. Pavlov, S. Yu.; Yuzgin, V. S. At. Energ. (USSR); 28: 254-5(Mar 1970). (In Russian).

Many radioisotopes distribute inhomogeneously in the body; for example, iodine-131 concentrates in the thyroid gland, Co-60 as an insoluble aerosol in the lungs, and Po-210 in the spleen. The counting efficiency depends on the distribution of the isotope in the human body. Experiments with Co-60 and I-131 were carried out. It was found that the maximum photoefficiency was about 25% greater with an inhomogeneous distribution of Co-60 than with a homogeneous distribution of the isotope. With I-131 it is found that about 33% of the total amount goes to the thyroid gland. The ratio of the inhomogeneous photoefficiency of the counter detectors to the homogeneous photoefficiency was found to be 1.2 which is in good agreement with the theoretical, calculated value. (TTT)

46488 SENSITIZATION OF IONOGRAPHIC EMULSIONS WITH POLYVINYL ALCOHOL. Tanaka, Keiichi; Demers, Joseph; Demers, Pierre (Univ. of Montreal, Quebec). Can. J. Phys.; 48: 1553-65(1 Jul 1970).

Ionographic emulsions were prepared using polyvinyl alcohol (APV) in place of gelatine by slightly modifying the method of Fujii et al., and without employing ammonia. Chemical sensitization was tried for recording RX (collective effect) and α rays (traces and collective effect) on this emulsion. Diphenylamine is useless, eosin has a weak effect, and sodium nitrite is fairly active. Sulfur (S) ($Na_2S_2O_3$) is better than TEA (triethanolamine), which causes more fog. In the case of TEA, soaking the dry film works better than adding it prior to pouring. TEA soaking of films poured with S is still better. When APV and galatine are compared there is a difference with respect to sensitivity and fog (galatine is superior). However, silver bromide sensitization in these two colloids obeys similar laws. S and TEA are effective, the latter especially by soaking, and TEA adds to the effect of S (hypersensitization). The sensitivity threshold, determined from the dose of 60 kV RX that produces a density of 0.2 above fog level, is 5 R for the non-sensitized emulsion and decreased to 0.75 R after sensitization. (auth)

46489 MEASURING THE SLOW NEUTRON FLUX BY MEANS OF THE HALL EFFECT IN SILICON. Kharchenko, V. A.; Solov'ev, S. P.; Novgorodtsev, R. B. At. Energ. (USSR); 28: 253-4(Mar 1970). (In Russian).

On irradiating silicon, nuclear transformations take place that end in the formation of the stable P-31 isotope, which is a donor impurity in silicon. On the assumption that each atom of impurity phosphorous puts one carrier in the conduction zone, it is possible to determine the concentration of phosphorous atoms from the change in value of the concentration of current carriers in the semiconductor. The slow neutron flux can then be calculated from the known activation cross-section. The main complicating factor is the presence of radiation defects which can be removed by annealing the sample after the irradiation. Values of the slow neutron flux were determined on the basis of changes in the concentration of phosphorous in six different samples according to the Hall effect. The results agree well with each other, and with the results obtained by foil activation analyses. One advantage of this method of determining neutron flux is that the dosimetric information is retained in the sample for an indefinitely long period of time. (TTT)

46490 ABSORPTION OF ELECTRON KINETIC ENERGY BY INORGANIC PHOSPHORS. Meyer, Vincent D. (Bayside Research Center, N. Y.). J. Appl. Phys.; 41: 4059-65(Sep 1970).

The fraction of the incident energy not absorbed by a phosphor has been determined by measuring the rediffusion coefficient and the energy distribution of backscattered electrons. Measurements for single crystals and powder samples have shown that a large fraction of the electrons scattered back from powder samples have undergone multiple backscattering, resulting in a reduction in the rediffusion coefficient. New estimates of the maximum attainable cathodoluminescence efficiency of ZnS:Ag have been made. (auth)

46491 GAS SCINTILLATION DETECTOR FILLED WITH HELIUM AT A PRESSURE OF 100 at. Schmidt, D.; Pose, H. (Technische Univ., Dresden). Kernenergie; 13: 148-50(May 1970). (In German).

The design of a gas scintillation detector developed for an operating pressure of 100 atm is described. Filling with a He–Xe mixture makes it, in particular, available for polarization analysis. Energy resolution and linearity as well as long-term stability have been studied. (auth)

46492 PHOTOMULTIPLIER WITH INWARDLY CONVEX PHOTOCATHODE FOR LOW-LEVEL SCINTILLATION COUNTING. Patzelt, Rupert; Halling, Horst (to Philips Corp.). United States Patent 3,515,872. 2 Jun 1970. Priority date 8 Feb 1966, Austria.

A photomultiplier tube for low-level scintillation counting with discrimination against noise pulses is described. A transparent photocathode is spaced from a first dynode in such manner that there is a systematic spread in the time of flight between the photocathode and the first dynode for electrons originating from different points of the photocathode, the time differences in the arrival of electrons at the first dynode determining the pulses to be counted. (auth)

46493 METHOD AND APPARATUS FOR POSITIONING A RADIOACTIVE STANDARD IN A RADIOACTIVE SAMPLE COUNTING APPARATUS. Smith, Roy E.; Olson, Robert E. (to Packard Instrument Co.). United States Patent 3,515,876. 2 Jun 1970. Filed 10 Apr 1967.

A pneumatic system is described for shifting a radioactive standard source from a remote location into a liquid scintillation counting chamber in which the standard source is located and retained within the counting chamber by magnetic attraction. (auth)

46494 ABSOLUTE DIRECT MEASUREMENT OF THE ACTIVITY OF PURE β EMITTERS BY LIQUID SCINTILLATION. Kolarov, V.; Le Gallic, Y.; Vatin, R. (CEN, Saclay, France). Int. J. Appl. Radiat. Isotop.; 21: 443-52(Aug 1970). (In French).

A method is described by which liquid scintillation measurement of the activity of pure β emitters can be corrected for the error due to zero probability. It makes use of the fact that when the activity of a source is measured by two phototubes three equations are obtained: measurement in each of the channels and coincidence or summation measurement, with three unknowns—activity of the source and conversion factor of each of the detectors. It is thus possible to arrive at the absolute activity of the sample. The theory is explained and the experimental apparatus described. (auth) (UK)

46495 INEXPENSIVE rf SHIELD FOR USE WITH RADIATION SURVEY INSTRUMENTS. Properizio, W. S. Health Phys.; 19: 442(Sep 1970).

The problems of rf interference and rf shielding are considered. The material used for the home-sewn shielding bag was a metalized heavy marquisette, an open-mesh nylon screen metalized with silver. The survey instrument exhibited a less than 10% variation in response, shielded vs. unshielded, for 12–34 keV photon beams. (UK)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 47566, 47567, 47577–47579, 47639, and 47668.

46496 (AERE-R-6060) NEUTRON SPECTRUM MEASUREMENTS OVER A WIDE ENERGY RANGE USING A SINGLE SEMICONDUCTOR SPECTROMETER. Silk, M. G.; Wright, S. B. (Atomic Energy Research Establishment, Harwell (England)). Jul 1970. 13p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

A single lithium-6 sandwich fast neutron spectrometer was used to study fast reactor neutron spectra over the energy range from 5 keV to 8 MeV—over three decades. The results obtained were in good agreement with theoretical and other experimental studies of the same spectra, from which it may be concluded that the errors introduced by uncertainties in the cross section of lithium-6 are not more than 10%. (auth) (UK)

46497 (BNWL-1285) EVALUATION OF Ge(Li) COMPTON SUPPRESSION SPECTROMETERS FOR NONDESTRUCTIVE RADIOCHEMICAL ANALYSIS. Cooper, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 19p. Dep. CFSTI.

Ge(Li) Compton suppression spectrometers are evaluated relative to the specific needs of the analytical radiochemist. Their application to the analysis of radionuclides found in neutron activation, fission product, and environmental radionuclide analyses is discussed. (auth)

46498 (CEA-N-1296) MEASUREMENTS ON AN AMPLIFIER FOR NUCLEAR SPECTROMETRY WITH BIPOLAR SYMMETRIC RESPONSE INDEX. Petin, Andre; De Rosny, Gerard (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires). Mar 1970. 45p. (In French). Dep. CFSTI (U. S. Sales Only).

Measurements of nuclear pulse amplifier characteristics are described. The pulse shaping network yields a bipolar output pulse having nearly equal amplitude positive and negative peaks. The network was designed by J. L. Blankenship and C. H. Nowlin. The measurements are chiefly related to linearity, overload, signal-to-noise ratio, and thermal stability features. (France)

46499 (IAE-1908) ANALYSIS OF EXPERIMENTS IN THE MEASUREMENT OF NEUTRON FLIGHT TIME. Petrov, A. P.; Petrykin, Yu. S.; Svrina, I. I.; Khovanskii, A. V. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1969. 28p. (In Russian). Dep. CFSTI (U. S. Sales Only).

This report is a brief analysis of the errors arising in a device for the measurement of neutron flight time. The purpose of the study is to investigate the possibilities for increasing the effectiveness (transmission) of the device through complicating the method of modulating the neutron flux from the source, and through additional processing of measurement data. (tr-auth)

46500 RECENT IMPROVEMENTS IN THE ARGONNE 7.7-m BENT-CRYSTAL SPECTROMETER. Smither, R. K.; Buss, D. J. (Argonne National Lab., Ill.). pp 55-63 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Recent improvements to the Argonne 7.7-m bent-crystal spectrometer have led to a doubling of its resolving power and to at least a 4-fold improvement in its sensitivity (ratio of diffraction peak to background) over the whole range of the spectrometer, and an improvement of 20-fold or more above 2 MeV. The energy range of the spectrometer was extended to cover the full (n,γ) spectrum from 20 keV to 6 MeV. (auth)

46501 THE AUTOMATION OF THE CURVED CRYSTAL SPECTROMETER AT RISOE. Koch, H. R.; Baader, H. A.; Breitig, D.; Muehlbauer, K.; Gruber, U.; Maier, B. P. K.; Schult, O. W. B. (Technische Hochschule, Munich. Risoe Research Establishment, Roskilde, Denmark). pp 65-74 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The automated curved crystal gamma spectrometer at Risø is described and new essential attributes are presented. An angular reflection width of 1.2'' can be obtained. The optimal energy resolution and the energy error of a single gamma reflection are given by $\Delta E(keV) = A \times E^{\frac{1}{2}} \times 10^{-6} \times 1/n$, where E is the gamma energy in keV and n the order of reflection. A is 2.5 if ΔE stands for the resolution, and 0.4 for the energy error. Strong transitions over 200 keV are measured in the 5th order. Results for the nuclei ^{153}Eu and ^{153}Eu are reported. (auth)

46502 FEASIBILITY STUDY OF AN INTERNAL PAIR FORMATION SPECTROMETER FOR NEUTRON CAPTURE SPECTROSCOPY. Michaelis, W ; Lange, D.; Wilhelmi, G. (Kernforschungszentrum, Karlsruhe, Ger.). pp 75-88 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The internal pair formation process may be utilized to investigate the multipolarity of high-energy transitions in neutron capture spectroscopy. For such measurements an instrument is needed that is based on the energy summing principle and that exhibits high resolution and sensitivity. The properties of a spectrometer, which consists of a silicon detector telescope, two NaI(Tl) scintillation detectors, and a superconducting magnet, are discussed. The detection efficiency and the multipolarity discrimination power are calculated using the Born approximation. The sensitivity to background radiation is investigated. A system of suitable design is proposed. The spectrometer may also be used for the measurements of internal conversion electrons. (auth)

46503 RESOLUTION FUNCTION OF A TWIN-ROTOR NEUTRON TIME-OF-FLIGHT SPECTROMETER. Komura, S.; Cooper, M. J. (Atomic Energy Research Establishment, Harwell, Eng.). Jap. J. Appl. Phys.; 9: 866-74(Aug 1970).

An analytic expression is derived for the resolution of a twin-rotor neutron time-of-flight spectrometer, assuming Gaussian time delay and collimation functions. A formulation is used which is similar to that used by Cooper and Nathans (Acta. cryst. 23 (1967) 357) in the derivation of the resolution function of a three-crystal neutron diffractometer, so that direct comparison of the results in the two cases is possible. The results of example calculations are also presented and discussed. (auth)

46504 ANALYSIS OF GAMMA-RAY SPECTROSCOPY DATA. Baran, J. A.; Reynolds, R. S.; Faw, R. E.; Kimel, W. R. (Kansas State Univ., Manhattan). Nucl. Appl. Technol.; 9: 591-604(Oct 1970).

A method of calibrating a lead-collimated, sodium iodide scintillation spectrometer is reported. Nine radioisotopes with gamma-ray energies in the range from 0.046 to 1.114 MeV were used. Details of the methods of data acquisition and reduction are presented. Methods are described for using response functions from the nine radioisotopes to generate response matrices for the energy from 20 to 1200 keV. Techniques for unfolding experimental data using response matrices are compared and a detailed error analysis is presented. For the routine analysis of experimental data using direct matrix inversion, a 25 × 25 response matrix with unequally spaced energy intervals over the range 20 to 1200 keV was found to be near optimum. (auth)

46505 ANALOG COMPUTER CONTROLLED GAMMA-RAY SPECTROMETER FOR COMPARATIVE ACTIVATION ANALYSIS. Jurs, P. C.; Isenhour, T. L. (Univ. of Washington, Seattle). Nucl. Appl. Technol.; 9: 584-90(Oct 1970).

An instrument has been designed, constructed, and tested which performs real time comparative activation analysis. The instrument directly compares the gamma-ray spectrum for a standard and a mixed unknown to determine the weight of the desired species in the unknown sample. The problem of resolution in activation analysis determinations is discussed. The mathematical basis, design, and operation of the instrument are described, and the results of two test determinations are given. (auth)

46506 GAMMA-RAY SPECTROMETER CALIBRATION FOR FIELD ANALYSIS OF THORIUM, URANIUM, AND POTASSIUM. Killeen, P. G.; Carmichael, C. M. (Univ. of Western Ontario, London). Can. J. Earth Sci.; 7: 1093-8(Aug 1970).

The calibration of a portable three-channel gamma-ray spectrometer for in situ analysis of thorium, uranium and potassium is discussed. A method of regression analysis is suggested as the best means of including all of the data available from the calibration stations. Calibration indicates a nonlinear relation between count rates obtained in the field and concentrations in parts per million obtained from laboratory analysis. The range of radioelement content must be taken into consideration and appropriate sets of calibration constants applied. As an example of the method, calibration constants are calculated for a portable gamma-ray spectrometer using data for the Blind River uranium region of Ontario. (auth) (Canada)

46507 LEAST SQUARES METHODS IN DATA ANALYSIS. Proceedings of the Symposium, Canberra, Australia, December 4, 1968. Andersen, R. S.; Osborne, M. R. (eds.). Computer Centre Publication CC 2/69. Canberra, Australia; Australian National University (1969). 131p. (CONF-681227).

A separate abstract was prepared for 1 of the 17 papers presented. The remaining 16 papers were not within the scope of NSA. (W.H.K.)

For an abstract of one paper see: 46508.

46508 LINEAR LEAST SQUARES FITTING OF GAMMA RADIATION SPECTRA. Hebbard, D. F. (Australian National

Univ., Canberra). pp 1-9 of Least Squares Methods in Data Analysis. /Andersen, R. S. (ed.). Canberra, Australia; Australian National Univ. (1969).

From Symposium on Least Squares Methods in Data Analysis, Canberra, Australia. See CONF-681227.

Histograms representing the frequency of occurrence of electrical pulses from a set of radiation detectors with defined amplitude limits, were fitted by first providing reference components (e.g., response to 2.36, 4.43, 6.13 and 8.06 MeV radiation), then generating selected components indicative of a given experiment. These components may be modified before performing the least squares fit. (Australia)

46509 AUTOMATIC NEUTRON ACTIVATOR ANALYZER. Jones, Robert E. Jr.; Price, Harold J. (to Kaman Sciences Corp.). United States Patent 3,515,868. 2 Jun 1970. Filed 23 Mar 1967.

A combination of a source of radiation, a sole radiation detector and a transfer mechanism separately supporting a known and an unknown sample in predetermined proximity to the source of radiation and designed to transfer the known and unknown samples in timed sequence to a detection position of predetermined proximity to the radiation detector in a manner to permit uniform repeatability with respect to time and proximity is described. The neutron activation system performs a quantitative analysis of the oxygen content in beryllium samples on a mass production basis. (auth)

46510 SPECTROMETER FOR NEUTRON TOTAL CROSS-SECTION MEASUREMENTS IN THE WAVELENGTH RANGE 8 TO 30 A. Todireanu, S.; Cioca, V. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 213-17(1970).

A spectrometer for total cross-section measurements at neutron energies smaller than 10^{-3} eV is described and the calibration of the device is discussed in detail. (auth)

High Energy Physics Instrumentation

Refer also to abstracts 47533 and 47534.

46511 (SLAC-PUB-801) WIRE SPARK CHAMBER SPECTROMETER AT SLAC. Armstrong, G. T.; Bulos, F. (Stanford Linear Accelerator Center, Calif.); Beniston, M. J.; (and others) (IBM Scientific Center, Palo Alto, Calif.). Sep 1970. 10p. (CONF-700902-4). Dep. CFSTI.

From International Conference on Instrumentation for High Energy Physics, Dubna, USSR.

The characteristics and performance of a wire spark chamber system using a secondary pion beam at SLAC for the study of reactions of the form $\pi^- p \rightarrow$ 2 or more charged particles are described. Topics discussed include the pion beam transport system; wire spark chambers, their associated H. V. pulsing system, and magnetostrictive readout; a large multi-cell Cherenkov counter; and computer facilities used in online and off-line analysis of data. The properties of this system with respect to its acceptance and resolution in mass, missing mass, and momentum transfer, are analyzed and examples presented. (auth)

46512 DETECTION OF X-RAY TRANSITION RADIATION BY MEANS OF A SPARK CHAMBER. Alikhanyan, A. I.; Avakina, K. M.; Garibyan, G. M.; Lorikyan, M. P.; Shikhlyarov, K. K. (Erevan Physical Inst.). Phys. Rev. Lett.; 25: 635-9(7 Sep 1970).

A new method for x-ray transition radiation detection by a streamer spark chamber is suggested. The use of the chamber secures a separate observation of both the radiation and the particle. It is shown that the mean number of the transition quanta linearly increases in the electron energy range 1.2 to 2.46 GeV. When plastic foam was used instead of a layered medium the efficiency of electron detection by transition radiation was 86%. (auth)

46513 BUBBLE-CHAMBER TECHNIQUE: RECENT DEVELOPMENTS AND SOME POSSIBILITIES FOR THE FUTURE. Derrick, M. (Argonne National Lab., Ill.). Progr. Nucl. Phys.; 11: 223-69(1970).

Topics include multiple expansions during each accelerator pulse, the need for new chambers and new designs, aspect ratio of the large chambers, general features of the designs, optimization of chamber size and magnetic field, some technical problems in the design of large chambers, neon–hydrogen mixtures, and bubble growth rates and bubble density. (54 references) (W.H.K.)

46514 POSSIBILITIES OF INVESTIGATING COSMIC MUONS USING A COMPLEX INSTALLATION. Agiamazov, V. A.; Bezus, V. A.; Gedevanishvili, L. D.; Kazarov, R. E.; Kirillov-Ugryumov, V. G.; Kotov, Yu. D.; Kuridze, R. E.; Rozental, I. L.; Sakvarelidze, I. I. Tr. Tbilis. Gos. Univ.; 133: 107-13(1969). (In Russian).

Various aspects of using a complex installation (Abstract 12V439) of the Institute of Physics of the Academy of Sciences Georgian SSR are discussed. The device is used to study the characteristics of a high-energy cosmic muon flux and to study muon interactions and determine the energy spectrum of muons involved in broad atmospheric showers. Preliminary experimental results obtained on the complex installation in 1965 are given. (JPRS)

Radiation Dosimeters

Refer also to abstract 46470.

46515 (AHSB(RP)R-100) AN IMPROVED METHOD OF FAST NEUTRON DOSE ASSESSMENT FROM THE AERE CRITICALITY DOSEMETER AND THE ACTIVATION OF BODY SODIUM. Adams, N. (United Kingdom Atomic Energy Authority, Harwell (England). Authority Health and Safety Branch). Jun 1970. 17p. Dep. CFSTI (U. S. Sales Only). UK 3s. 0d.

An improvement in the accuracy of fast-neutron dose assessment from the AERE criticality dosemeter is shown to be possible by means of the assumption of a fast neutron spectrum with one adjustable parameter. The value of this parameter together with the total fast neutron fluence was derived from the fast neutron activation of the indium and sulphur components of the dosemeter. The activation of the body sodium of the dosemeter's wearer was similarly combined with the activation of the sulphur component. Experimental evidence obtained in the Fifth International Intercomparison of Nuclear Accident Dosimetry Systems, ORNL, July, 1968, has demonstrated this improvement. Theoretical evaluation of the fast neutron dose for a wider range of reactor leakage spectra, using either indium/sulphur or sodium/sulphur activation, gave dose estimates of acceptable accuracy except for the estimate for one spectrum using indium/sulphur. Acceptable accuracy for all these spectra was obtained by averaging the estimates made using the two pairs of activations. Averaging these dose assessments provides a convenient way of combining the evidence available in the activations of sodium, indium, and sulphur which is of promising value for routine use. (auth) (UK)

46516 (DESY-70/27) COMPARISON OF HEALTH PHYSICS MEASURING PROCEDURES AT ACCELERATORS. Freytag, E.; Nachtigall, D. (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). Jun 1970. 14p. Dep. CFSTI (U. S. Sales Only).

A tabular summary of the different measuring procedures and instruments used for radiation dosimetry at 23 accelerator centers in Japan, North America, and Western Europe is presented. The lists contain 42 different procedures and instruments. (W.H.K.)

46517 (ZJE-84) CALORIMETRIC MEASUREMENTS IN NUCLEAR ENGINEERING. Kott, J.; Teren, S.; Jirousek, V. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 6p. Dep. CFSTI (U. S. Sales Only).

Information concerning the use of calorimeters developed in the ŠKODA Nuclear Power Plant's division for the measurement of the gamma radiation intensity is presented. This information is of great importance in the case of reactor structural materials, the heating of which due to radiation may deserve serious consideration. (auth)

46518 LUMINESCENCE OF THE AIR CAUSED BY FAST ELECTRONS. Vagin, Yu. P.; Kabanov, G. L.; Medvedev, Yu. A.; Neshkov, D. Z.; Stepanov, B. M. At. Energ. (USSR); 28: 177-8(Feb 1970). (In Russian).

Preliminary studies were carried out on the potential use of the fluorescence of air as a low-inertial pulse dosimetry method for strong, nonstationary high energy electron fluxes and γ quanta. Passage of $0.2 \leq E_\gamma < 10$ MeV γ quanta through the air creates E_γ-energy electrons by means of the Compton effect. The primary electrons generate secondary δ electrons. The intensity of the flares is due to the relatively slow δ electrons which are proportional to the primary flux or γ quanta; therefore, the intensity of the luminescence is proportional to the absorbed primary γ radiation dose. As the transformation of the γ ray energy into light energy involves fast electrons, the experiments may be conveniently carried out with electrons from a linear accelerator. Time resolution of 10^{-7} sec may be thus obtained. It was experimentally shown that there is a linear correlation between the electron current and the light intensity. These preliminary results may serve as a basis for a pulse dosimetry method. (TTT)

46519 INTERNATIONAL COMPARISONS OF IONIZATION CHAMBERS FOR ABSOLUTE MEASUREMENTS OF THE ROENTGEN AT PHOTON ENERGIES OF ABOUT 1 MeV. Rakow, A.; Will, W.; Yudin, M.; Ostromuchova, G.; Kononova, R.; Marsh, A. R. S.; Dale, J. W. G. (Deutsche Akademie der Wissenschaften, Berlin. Inst. of Metrology, Leningrad. National Physical Lab., Teddington, Eng.). Acta Radiol., Ther., Phys., Biol.; 9: 144-54(Apr 1970).

The primary standard cavity ionization chambers of DAW Berlin were compared with the primary standard high-pressure ionization chambers of VNIIM Leningrad using their ^{60}Co unit, and with the primary standard cavity ionization chambers of NPL Teddington using their 2 MV Van de Graaff roentgen ray generator. With correction factors thought by the respective centers to be most appropriate, the comparisons showed agreement to about one per cent, which is within the estimated limits of accuracy claimed. (auth) (Sweden)

46520 UV DOSIMETRY BY ZnS ELECTRET DISCHARGE. Fabel, G. W.; Henisch, H. K. (Pennsylvania State Univ., University Park). Solid-State Electron.; 13: 1207-12(Sep 1970).

A method of uv dosimetry is described which depends on electric depolarization in single crystal and powder specimens of ZnS by the incoming radiation. The residual polarization can be measured by optical or thermal readout procedures. In both cases, the mechanism is electronic. The dosimetric characteristics of these systems are described and comparisons made with corresponding dosimetric procedures based on pyroelectricity and current-glow. Measurements of the type described also yield information on trap distributions in insulators. (auth) (UK)

46521 THERMOLUMINESCENT DOSIMETER OF LiF INCORPORATED IN SILICONE RUBBER. Bassi, P.; Busuoli, G.; Cavallini, A.; Rimondi, O. (CNEN, Bologna). Minerva Fisiconucl.; 13: 276-81(Oct-Dec 1969).

The fabrication and performance of discs of silicone rubber with incorporated LiF are described. The use of discs is practical, whereas the use of loose powder is not. Discs have the same sensitivity and linearity as loose powder, with a higher energy dependence, and can be reused a certain number of times. (auth)

46522 COMPARISON OF LITHIUM FLUORIDE AND FILM FOR PERSONAL DOSIMETRY OF X- AND GAMMA RADIATIONS. Busuoli, G.; Cavallini, A. (CNEN, Bologna). Minerva Fisiconucl.; 13: 265-70(Oct-Dec 1969).

A comparison between the dose measurements obtained with film dosimeters and LiF powders is made. Tests were carried out on detectors, powders and films, first as exposed when employed in the routine personal dosimetric service and then as exposed under experimental conditions to known doses at various energies. The experimental results make it clear that both dosimetric methods are satisfactory from the point of view of personal dosimetry. (auth)

46523 SUPRALINEARITY OF THERMOLUMINESCENT PHOSPHOR LITHIUM FLUORIDE. Hwang, F. S. W. (Univ. of Birmingham, Eng.). Nature (London); 227: 269-70(18 Jul 1970).

It is stated that the non-linear dose response reported for many thermoluminescent phosphors has caused serious concern both in dosimetry and dating techniques. An investigation is reported on samples of TLD100 phosphor, in which the thermoluminescence output induced by a ^{90}Sr source was measured in oxygen-free nitrogen using a heating rate of 20°C/sec. In addition to the known peaks a tail was observed at the higher temperature regions, and a detailed study of this tail revealed at least two peaks in its fine structure; these two peaks increased with dose to saturation at ~3 MR. The peak positions were at 370°C and 430°C, and the structure of the tail and its dependence on dose are shown graphically. Thermal annealing was performed in order to study the characteristics of these peaks; both peaks were found to tail off-exponentially at constant temperature, and the dependence of the half-lives of both peaks on annealing temperature was found to be the same as for the previously known peaks. The facts suggested that the peaks were not related to electron trapping centers, but an optical absorption measurement on the irradiated phosphor indicated that they were related to the absorption V-center of 250 nm. The absorption spectrum of the irradiated phosphor and changes due to different quenching temperatures are shown graphically. The height and area of the peaks were found to increase linearly with dose in the region of a few kR. A striking fact was that by extrapolating to zero glow there was a threshold dose of 1 kR for production of these peaks by radiation, coinciding with the dose at which supralinearity is reported to begin in TLD100. The facts also suggested that extra light should be expected as more recombination centers are available, and if it is assumed that the supralinearity is due to extra recombination centers produced by high energy particles then it should depend universely on the LET of the radiation. (UK)

46524 PERSONNEL RADON DOSIMETER. Becker, Klaus H. (to U. S. Atomic Energy Commission). U. S. Patent 3,505,523. 7 Apr 1970. Filed 2 Aug 1968.

An organic polymer foil, such as cellulose triacetate, mounted within a holder and worn on a person has been found to be an efficient and accurate dosimeter for radon and its daughter products. This material is insensitive to light and sufficiently insensitive to temperature and humidity such that it may be used in uranium mines and other environments where these injurious agents may be present. Simple etching of alpha particle tracks which are registered in the foil makes them visible at low power magnification, and radiation dose may then be estimated by conventional or automatic track counting techniques. (auth)

46525 DOSIMETER WITH TRANSPARENT ELECTRODE. Hosemann, Rolf; Basler, Guenther; Schiekel, Manfred (to Telefunken Patentverwertungsgesellschaft mbH). U. S. Patent 3,508,054. 21 Apr 1970. Priority date 15 Apr 1965, Germany.

A dosimeter for measuring radiation includes an outer cylinder constituting a first electrode, an inner transparent rod constituting a second electrode and arranged concentrically with respect to the cylinder, a movable electrometer mounted within the outer cylinder and adjacent one end of the inner rod whereby it may be observed by light passing through the transparent rod. (auth)

Radiometric Instruments

46526 (INP-700) ELECTRON CAPTURE TYPE DETECTOR: MODEL DNW-300/68 FOR GAS CHROMATOGRAPHY. Lasa, J.; Owsiak, T. (Institute of Nuclear Physics, Krakow (Poland)). 1970. 12p. Dep. CFSTI (U. S. Sales Only).

In the paper, basic parameters characterizing a new construction of the detector devoted to the detection of electron capturing components are presented. In the detector ^{63}Ni was used as the source of ionizing radiation. The special construction of the detector makes possible its permanent operation at temperatures up to 400°C. (auth)

46527 (TID-25484) ADDITION OF AUTOMATIC TEMPERATURE AND PRESSURE SENSORS TO UNDERWATER GAMMA SPECTROMETER. Riel, Gordon K. (Naval Ordnance Lab., White Oak, Md.). 24 Mar 1969. 20p. Dep. CFSTI.

Radioisotope gages to measure temperature and pressure were incorporated into the Naval Ordnance Laboratory's Deep Underwater Gamma Spectrometer. With this change, underwater radiation spectra can be related to other oceanographic measurements. The radioisotopes, ^{204}Tl and ^{57}Co, are mounted on conventional sensors, so that the radiation intensity reaching the detector is a function of temperature or pressure. Energy analysis separates the gage counts from each other and the environmental radiation. Only 5% of the energy scale is used for these gages. If environmental spectra were not required, this technique could be expanded to accommodate 20 gages on 1 detector. (auth)

46528 NEW X-RAY SEDIMENTOMETER. Allen, T.; Svarovsky (Univ. of Bradford, Eng.). J. Phys., E (London); 3: 458-60(Jun 1970).

Powder technology is a field which demands a thorough knowledge of the properties of powdered materials, the most basic property being the particle size distribution. There is a need for an instrument which will give the weight distribution of powder samples in suspension quickly and reliably with the minimum of interference. X-ray analysis fulfills this need for a wide range of powders and the instrument described using a ^{147}Pm/Al source, has the added advantage of simplicity of operation and reasonable cost. (auth) (UK)

46529 THICKNESS AND DENSITY MEASUREMENTS WITH THE AID OF NUCLEAR RADIATION. Langel, H. (Frieseke and Hoepfner GmbH, Erlangen, Ger.). Kerntechnik; 12: 219-26(May-Jun 1970). (In German and English).

The basic principles and the applications of facilities for measuring area densities and thicknesses with the aid of nuclear radiation are described, including recent developments such as the use of fluorescent radiation induced by ^{241}Am. Examples are given and designs of appliances are described, including the possibilities of connection to process computers. The diverse application possibilities of backscatter measuring techniques are discussed. Density measurement techniques, whose range of application has been increased by the use of ^{241}Am, and flow rate measurement techniques based on measured values of density or of area density, are also discussed. (auth)

46530 THICKNESS GAUGE FOR FAST MOVING DISCONTINUOUS MATERIALS. Duftschmid, Klaus E.; Steidl, Johannes; Patzelt, Rupert; Attwenger, Wolfgang (to Osterreichische

Studiengesellschaft fuer Atomenergie, GmbH). U. S. Patent 3,497,693. 24 Feb 1970. Priority date 19 Mar 1965, Austria.

THICKNESS GAGES—design of radiometric, for fast moving materials. (W.H.K.)

46531 PRINTING AND READOUT SYSTEM UTILIZING CODING COMPONENTS FOR SYMBOLS, EACH COMPONENT HAVING MATERIALS WHICH ABSORB RESONANTLY DIFFERENT GAMMA RAYS AND CAUSE SCATTERED RERADIATION, THE READOUT SYSTEM INCLUDING A SOURCE OF DIFFERENT GAMMA RAYS CORRESPONDING TO EACH OF THE CODING COMPONENTS. Hannan, Roy Barton (to American Cyanamid Co.). U. S. Patent 3,506,829. 14 Apr 1970. Filed 9 Feb 1966.

Coded symbols are formed of inks which have present one or more components of the code in the form of materials which when irradiated with certain bands of recoilless gamma radiation absorb it and reradiate it in all directions (Moessbauer effect). The code may be the presence or absence of a component, in which case the number of symbols which can be represented is $2^n - 1$, where n is the number of different components. In order to read out the code, the symbol is irradiated with recoilless gamma radiation either with all of the wavelengths to which different components respond or serially with individual ones, and if a particular component is present it absorbs its radiation and reradiates in all directions. Detection can then be obtained by the detector responsive to the particular radiations. (auth)

46532 SCINTILLATION-TYPE FAST NEUTRON WELL LOGGING DEVICE. Paap, Hans J.; Hall, Hugh E. Jr. (to Texaco Inc.). U. S. Patent 3,510,654. 5 May 1970. Filed 22 Dec 1965.

A fast neutron moisture gage for well logging is described. A pulse discriminator system is used with a scintillation detector for selective gamma detection, selective fast neutron detection, or coincidence fast neutron–gamma detection. (W.H.K.)

46533 HIGH-SPEED NUCLEONIC MEASURING SYSTEM. Chope, Henry R.; Griffith, James L.; Spitz, David A.; Dewey, Rex W.; Troutman, Paul H. (to Industrial Nucleonics Corp.). United States Patent 3,513,310. 19 May 1970. Filed 10 Mar 1967.

In a null self-balancing system for measuring a material characteristic, such as basic weight with a radiation gauge, use is made of the summation of the slow or mechanical feedback voltage or its counterpart and the fast or electronic output voltage from an amplifier receiving the transducer signal, to obtain from the summation voltage a fast response signal which represents information concerning the characteristic of the material being measured. The signal is obtained at a rate faster than a signal having similar information can be obtained from the mechanical feedback. The summation voltage is provided in a variety of ways including directly from the circuit itself, or from an additional slidewire electrically connected across the measuring slidewire, or from an independent slidewire the output of which is applied to a summing circuit in conjunction with an output from the amplifier. Variations in span may be compensated for in various ways including regulation of the amount of amplifier output voltage or of the other voltage summed, and source standardizing variations in the summed voltage are compensated for in various ways, so that the fast response signal is fully calibrated and can be used to indicate values of the material characteristic or to control that characteristic while the material is being manufactured for example. (auth)

Miscellaneous Instruments and Components

Refer also to abstracts 46397, 46468, 47638, 47891, and 47984.

46534 (AECL-3470) PERFORMANCE OF A MULTI-PURPOSE INSTALLATION OF COMPUTER OPERATED MASS SPECTROMETERS. Bell, D.; Stewart, R. B. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Apr 1970. 12p. Dep. CFSTI (U. S. Sales Only). AECL $0.50.

A small on-line computer has been set up both to control the operation and process the data from two analytical mass spectrometers. It has been programmed to handle the varied requirements of a low resolution gas instrument and the isotopic measurements for a thermal ionization solids instrument. Comparisons are given of results from the computer system to those obtained manually from a recording potentiometer. Other data on standard samples are included. (auth)

46535 (BRH/DEP-70-16) NEAR FIELD INSTRUMENTATION. Rudge, A. W.; Knox, R. M. (IIT Research Inst., Chicago, Ill.). Jul 1970. Contract CPE-R-69-23. 69p. CFSTI.

A near-field probe for measuring electromagnetic radiation was developed. The probe employs diode detectors and is designed to minimize interactions with the field being measured. This report discusses the problems associated with measuring electromagnetic radiation and describes the design, construction, and calibration of the prototype probe. (auth)

46536 (CEA-CONF-1542) OBTAINING OF NUMERICAL RESULTS FROM A MASS SPECTROMETER. Rion, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 11p. (In French). (CONF-700513-2). Dep. CFSTI (U. S. Sales Only).

From 5th International Measurement Confederation Conference, Versailles, France.

Equipment developed for automatically treating mass spectrometer results was described. (France)

46537 (IN-1413) HIGH TEMPERATURE ULTRASONIC THERMOMETER FOR MEASURING REACTOR FUEL TEMPERATURE. Arave, A. E.; Meservey, R. H. (Idaho Nuclear Corp., Idaho Falls). Aug 1970. Contract AT(10-1)-1230. 23p. Dep. CFSTI.

An Ultrasonic Thermometer (UT) is being developed at the National Reactor Testing Station for use in making internal fuel temperature measurements in high temperature reactors. Of primary interest are the fuel temperatures in the Loss-of-Fluid Tests (LOFT) and in the Power Burst Facility (PBF). Both reactors will produce peak fuel temperatures of about 2450°C. The LOFT application is a steady state measurement, while the PBF requires response times in order of tenths of a second. The UT is a refractory wire in which the ultrasonic wave propagation time is a function of temperature. The refractory metal sensor is selected to meet the environmental and accuracy requirements of the measurement. The UT has been tested out-of-pile at temperatures up to 2600°C, and in in-pile transient tests at temperatures up to 1800°C. The accuracy of the UT is ±25°C, which is about ±1% at the highest temperatures expected. (auth)

46538 (NP-18347) COMBINATIONAL AND SEQUENTIAL TECHNIQUES FOR THE COMPRESSION OF BINARY DATA WITH APPLICATION TO SPACE PHYSICS EXPERIMENTS. Note No. 258. Cantarano, S.; Pallottino, G. V.; Palutan, F. (Rome Univ. (Italy). Istituto di Fisica). 25 Mar 1970. 113p. Dep. CFSTI (U. S. Sales Only).

The general problem of data compression or data redundancy reduction is studied. An effort has been made to report some of the most significant results obtained in this field in a unified fashion by analyzing the various techniques that have been proposed and applied to several space physics experiments. Some of these techniques are implemented by counting pulses, that correspond to certain events such as particle detection, according to suitable laws with counters with variable structure, that is the compression is actually obtained at the same time of the counting. Some possible counting laws are discussed such as the logarithmic one and those based on the statistical error pertinent to a stream of random pulses as well as on all the a priori knowledge about the expected count. Other techniques on the contrary can also be applied to the compression of binary numbers, such as the floating point technique and those based on the use of combinational networks and read-only-memories (ROM). Some of the results of the work described have been successfully used for the experiment S 73 on board the HEOS 1 ESRO satellite, launched on December 1968, and are being used for the experiment S 202 on HEOS 2 ESRO, and ERI on the italian satellite SIRIO. (auth)

46539 (UUIP-704) X-RAY FLASH TUBE WITH EXCHANGEABLE ELECTRODE SYSTEM. Hoegberg, L.; Mattsson, A.; Nilsson, N. R.; Svedberg, A. (Uppsala Univ. (Sweden). Inst. of Physics). Apr 1970. 14p. Dep. CFSTI (U. S. Sales Only).

Design and performance data of a field emission x-ray flash tube are presented. The electrode assembly is exchangeable. It is thus possible to adapt the tube impedance to the voltage source or to replace the anode tip when necessary. The tube was tested in the voltage range 100 to 1200 kV; the pulse width at 1200 kV is typically 10 ns and the penetration 5 cm of steel at 1 m. (auth) (Sweden)

46540 CALCULATION AND OPTIMIZATION OF HELICAL EXPLOSIVE GENERATORS. Auvray, Etienne; Besancon, Jacques E.; Ducauze, Alain (Centre d'etudes de Limeil, Villeneuve-Saint-Georges, France). Rev. Phys. Appl.; 5: 301-8(Apr 1970). (In French).

A theoretical study was made of current generators using coil compression. Two designs were considered. In one of them the pitch was continuously variable, in the other one a multistaged

coil was used. In both cases the pitch variation as a function of the distance from an individual coil turn to the end load was calculated assuming that the current gain is maximum. The main losses due to the Joule effect created by the field diffusion through the coil turns were taken into account. The parameters were adjusted with the experimental results for the theory to be of practical use. Another cause of energy losses was a side movement of the metal conductors due to the magnetic forces. These losses were negligible for high gain coils but were shown to increase with the square power of the Joule effect losses. (France)

46541 CALIBRATION OF A He(I) PHOTOELECTRON SPECTROMETER. Lloyd, D. R. (Birmingham Univ., Eng.). J. Phys., E (London); 3: 629-32(Aug 1970).

A set of accurately known calibration points for He(I) photoelectron spectroscopy is tabulated. The set covers the range of ionization potential from 7.02 to 21.19 eV, or of electron energy from 14.20 to 0.03 eV, at intervals of less than 1 eV over most of the range. It is shown, by using these points, that a commercial electrostatic deflection analyzer instrument is linear in electron energy at electron energies above 6 eV, but that at lower energy there is a progressively increasing deviation from linearity. (auth) (UK)

46542 DIGITALE LOGIK. (Digital Logic). Stuckenberg, Hans-Joachim. Nukleare Elektronik und Messtrechnik, Bd. 1. (Nuclear Electronics and Measuring Techniques, Volume 1). Karlsruhe, Ger.; G. Braun (1970). 189p. DM 22,40.

Digital logic is treated especially from the standpoint of application for electronic equipment in nuclear installations. Since application and not development of such equipment is emphasized, theory of circuitry is suppressed in favor of description of equipment and techniques. Understanding of instruments and their functions is stressed in such a way that they can be effectively used for the designing and performing of nuclear experiments. Digital logic, digital gates, semiconductors, integrated circuits, arithmetic operations, and control logic are discussed. (H.B.G.)

46543 SVOISTVA POLUPROVODNIKOVYKH PRIBOROV PRI DLITEL'NOI RABOTE I KHRANENIE. (Properties of Semiconductor Devices after Long-Term Operation and Storage). Goryunov, N. N. Biblioteka po Radioelektronike. Vypusk 23. Moscow; Energiya (1970). 104p.

Properties of semiconductor diodes and transistors during continuous work and long-term storage are discussed. The reliability tests, physical basis for evaluating reliability of the devices, degradation and breakdown with the appearance of crystals on the surface, failure of planar transistors, and cumulative degradation of tested models are evaluated. Design guides to construct reliable instruments and an analysis of device parameters and time–load performance are given. (42 references)

46544 PRE-ACCELERATING SPECTROGRAPH FOR THE STUDY OF LOW-ENERGY ELECTRON SPECTRA AND AUGER SPECTRA OF ^{233}U, ^{125}Te, ^{109}Ag, AND ^{195}Pt. Pou, Wendell Morse Jr. Nashville; Vanderbilt Univ. (1969). 169p. University Microfilms Order No. 70-5419.

Thesis.

This dissertation describes a permanent-magnet, semicircular spectrograph that records electron spectra in the energy range from about 2 to 40 keV. Instrumental momentum resolution is about 0.1%. Relative uncertainties of energy measurements and intensity measurements are approximately 0.2% and 20%, respectively. Photographic plates, which are commonly used to detect electrons in semicircular spectrographs, have very low sensitivity to low-energy electrons. To reduce the time required for proper exposure, several investigators have used electrostatic fields to accelerate electrons to energies for which sensitivity is greater. The spectrograph described in this dissertation has a cylindrical accelerating chamber. It is shown that an accelerating field having cylindrical symmetry produces a negligible distortion of a spectrum. Measured energies and relative intensities of lines in the Auger spectra of ^{233}U, ^{125}Te, ^{109}Ag and ^{195}Pt are given, and comparisons of these measurements with theoretical values are made. (Diss. Abstr.)

46545 DEVELOPMENT OF AN EXPERIMENTAL DEVICE TO STUDY ELECTRON SCATTERING BY ATOMS AND MOLECULES. Le Nadan, A.; Gelebart, F.; Pochat, A. (Brest Univ., France). Method. Phys. Anal.; 62: 178-81(Jun 1970). (In French).

An electron spectrometer using two 127° electrostatic selectors was constructed to study the scattering of low-energy electrons by atoms and molecules. (tr-auth) (France)

46546 FAST HIGH-PRECISION ANALOG DIGITAL CONVERTER FOR PULSE SPECTROMETRY. Patzelt, Rupert (Reaktorzentrum, Seibersdorf, Austria). Acta Phys. Austr.; 30: 17-56(1969). (In German).

An ADC with the following specifications has been designed and constructed: 8192 channels, amplitude range 0.05 to 10 V, positive conversion time 12 μsec max, integral linearity better than $\pm 2.5 \times 10^{-4}$, stability of channel-width 0.5%. In a modification of the linear capacitor discharge a coarse and a fine measurement is executed subsequently, combined of a fast discharge and a interpolation with a slow discharge. The address oscillator works at 20 MHz, the address register is advanced during the coarse measurement in steps of 64 channels and during the fine measurement channel by channel. The discharge current generators are switched in exact synchronism with the pulses of the address oscillator; a two-step-synchronizing circuit is used. Special circuits have been developed for the pulse stretcher, the current generators, current switches and the discriminator. The high degree of stability and linearity is achieved through the proper use of field effect-transistors, linear integrated circuits and fast digital integrated circuits (emitter-coupled logic). Details of the tests performed and the testing methods are given. (auth)

46547 SPENT FUEL PROCESSING AT LA HAGUE. THE SODERN FIRE DETECTOR AND ALARM. Prot. Civ. Secur. Ind.; No. 188, 7-10(Jun 1970). (In French).

Infrared detectors are used at the La Hague center to monitor radioactive uranium slugs stocked in the storage rooms. The principle of the apparatus is based on detection of the infrared flux emitted by a hot body to which is coupled an optical system for spotting the target point. The detection of a hot point is achieved materially by the use of an audible signal and the control panel display of a light signal corresponding to the rod on which the abnormal temperature increase has been detected. (auth) (France)

46548 ELECTRONIC MONITORING OF NANOSECOND PULSES FROM A FIELD EMISSION ELECTRON SOURCE. McDonald, J.; Weiss, H.; Pinkerton, A.; Epp, E. R. (Sloan-Kettering Inst. for Cancer Research, New York). Radiat. Res.; 43: 514-24(Sep 1970).

A monitoring system utilizing a pickup loop has been developed to observe the pulse-to-pulse output of an electron source which exploits the phenomenon of field emission. This source is currently being used for cellular radiobiological experiments and for dosimetry investigations under ultra high dose rate conditions. The output of the source provides a 3 nanosecond pulse of electrons whose average energy is 530 keV. The monitoring system has been calibrated against a Faraday cup and an intensity-measuring calorimeter. Computerized least squares analyses of the data show a linear correlation between the monitor and either the Faraday cup or the intensity calorimeter to within a standard deviation of about ±1%. (auth)

46549 REMOTE LEVELLING MEASUREMENT. Blesch, Robert A.; Porter, Charles G.; Reading, Oliver S. (to U. S. Atomic Energy Commission). United States Patent 3,520,621. 14 Jul 1970. Filed 12 May 1967.

Apparatus which utilizes a collimated beam of light to indicate the roll and pitch of a device is described. The device is provided with a pool of mercury whose free surface is damped by high viscosity oil to establish a horizontal surface and also a plano-parallel optical flat which is partially silvered. The flat is parallel to the plane of the device whose level is to be indicated. A collimated beam is reflected by both the silvered surface and the free mercury surface, and the degree of separation of the reflected beams is an indication of the angular position of the optical flat. This device was designed for use in leveling the large magnets (240) in the Brookhaven Alternating-Gradient Synchrotron. (auth)

46550 CONNECTOR. Bonniaud, Roger; Martin, Guy; Sumian, Guy (to Commissariat a l'Energie Atomique). British Patent 1,198,775. 15 Jul 1970. Priority date 1 Mar 1967, France.

A connector is described that is particularly useful for application in the nuclear field in which plugging-in must be controlled through biological shields. The connector comprises a fixed support and a movable support which are connected to each other by articulation means constituted by a conical part fast with one support and a spherical part fast with the other support. The spherical part is located in the conical part, and at least one female junction element is mounted on one support and at least one male junction element is mounted on the other support. The male element(s) is engagable in the female element(s) to establish a connection when the movable support is moved towards the fixed support. Each junction element is pivotally mounted on its support, and each has resilient restoring means for returning it to a predetermined position with respect to the support when the elements are disengaged. (B.L.M.)

46551 IMPROVEMENTS RELATING TO SEQUENTIAL SAMPLE ANALYSIS. Pollard, Alan; Wright, Alfred George (to Wright Scientific Ltd.). British Patent 1,187,202. 8 Apr 1970. Filed 14 Mar 1966.

ANALYTICAL CHEMISTRY — equipment for sequential sample analysis, filtration

RADIOIMMUNOASSAY — equipment for sequential sample analysis, filtration (W.H.K.)

Radiation Effects on Instruments and Instrument Components

46552 (BNWL-1436) EFFECTS OF GAMMA RADIATION ON THE PIEZOELECTRIC PROPERTIES OF LITHIUM NIOBATE. Smith, R. W. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. Contract AT(45-1)-1830. 14p. Dep. CFSTI.

Lithium niobate can be used to significantly extend the operating temperatures of ultrasonic transducers. Since some high-temperature transducer applications involve exposure to nuclear radiation, it is important to determine the effect of this radiation on the piezoelectric properties of the transducer crystal. In this work we measured the effect of gamma radiation on the piezoelectric properties of lithium niobate crystals. We exposed x-cut and z-cut lithium niobate transducer plates to gamma radiation from a ^{60}Co source. The electromechanical coupling factor, the dielectric constant and the frequency constant were measured before exposure and at periodic intervals up to 10^{10}R, total dose. We could detect no significant change in any of these parameters up to 10^{10}R. This indicates that lithium niobate is well suited for applications involving exposure to high levels of gamma radiation. (auth)

46553 (CONF-700330-1) SOLAR CELL RESEARCH AT COMSAT. Curtin, D. J. (Communications Sattelite Corp., Clarksburg, Md.). 1970. 6p. Dep. CFSTI (U. S. Sales Only).

From Solar Energy Society Conference, Melbourne, Australia.

A survey of the solar cell research program at COMSAT Laboratories is presented. The results discussed include data from studies of low energy proton irradiations on partially shielded silicon solar cells, 1 MeV electron irradiations on silicon solar cells, and proton irradiations and thermal cycling of cadmium sulfide solar cells. (auth) (Australia)

46554 MONOLITHIC RADIATION-HARDENED OPERATIONAL AMPLIFIER. Stafford, Kenneth R.; Oberlin, David W. (Fairchild Semiconductor, Research and Development Lab., Palo Alto, Calif.). Solid State Technol.; 13: No. 5, 67-72(May 1970).

Radiation resistant integrated circuits are required for many applications in nuclear environments. The design and fabrication of a radiation resistant operational amplifier are described. The fabrication process utilizes dielectric isolation and thin film resistors to limit radiation-induced photocurrents; gettering and silicon nitride passivation are used to improve transistor h_{FE} and long-term stability. The use of photocurrent compensation diodes is discussed, and the circuit operation is described. The circuit has good electrical performance including latch-up protection and short circuit protection. The variation of key electrical parameters with accumulated neutron dose is presented. (auth)

46555 IRRADIATION OF INSULATING FOILS WITH LOW ENERGY ELECTRONS (100 TO 3000 eV). Mayoux, Christian; Teisseyre, Yves (Laboratoire de Genie Electrique, Toulouse). Compt. Rend., Ser. B; 270: 1521-4(15 Jun 1970). (In French).

The degradation of an organic insulator by an incident electron beam is studied by analyzing the nature of the perturbations resulting from the charges deposited at the surface of the target during a continuous beam irradiation. The secondary emission from the material is taken into account and the real accelerating voltage of the incident electrons is considered. (auth) (France)

46556 EFFECT OF γ RADIATION ON REVERSE CURRENT IN SILICON p-n JUNCTIONS. Krivov, M. A.; Malyanov, S. V.; Smirnov, L. S. (Tomsk State Univ., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 8, 70-4(1969). (In Russian).

The effect of x-ray radiation of the volt-ampere characteristics of germanium and silicon p-n junctions was studied previously. The behavior of silicon p-n junctions during and after irradiation by Roentgen rays on the Rup-200 and URS-55 apparatus was studied. During irradiation the heating of the samples was insignificant: their temperature for the time of irradiation rose not more than 1°C. Irradiation of silicon p-n junctions by x-rays promotes the creation of a stable long-lived trap in the volume and on the surface of the base, the increase of the charge carrier lifetime, and consequently, the decrease of the back current through the p-n junction. The application of constant voltage during irradiation increases the velocity of the trap. The decrease of back currents after prolonged x-ray irradiation can also be caused by a change of state of the surface of the crystal as a result of the ionization of the surrounding medium. (tr-auth)

46557 INTERACTIONS BETWEEN RADIATION FIELDS FROM RADIOISOTOPE THERMOELECTRIC GENERATORS AND SCIENTIFIC EXPERIMENTS ON SPACECRAFT. Miller, C. G.; Truscello, V. C. (California Inst. of Tech., Pasadena). Nucl. Appl. Technol.; 9: 722-35(Nov 1970).

A study was made to determine the extent of the interference that may be expected in the operation of spacecraft science instruments when the spacecraft carries a radioisotope thermoelectric generator. Suitable analytical models were developed to predict the effects of the radiation spectrum on the various selected components. The gamma radiation was expressed as a 20-group structure between the energies of 40 keV and 10 MeV; the detectors selected for detailed evaluation were (1) Geiger-Muller tubes, (2) Continuous-Channel Electron Multipliers, and (3) Silicon Surface Barrier Detectors. The conclusions were that with reasonable separation between the radioisotope thermoelectric generator and the sensitive science components (≈15 ft) individual detectors would require a pound or less of shielding material in order that an acceptable spurious counting rate would be achieved. For a typical spacecraft payload, including such experiments as the cosmic ray telescope, trapped radiation detector, and low-energy proton and electron differential energy analyzer, less than 10 lb of shielding would be required. Recommendations for developmental methods that could lead to means to reduce this amount of shielding were also made. (auth)

46558 DIRECTIONAL EFFECTS IN THE SCINTILLATION RESPONSE OF ANTHRACENE CRYSTALS BOMBARDED BY PROTONS IN THE ENERGY RANGE 200 TO 600 keV. von Szalghary, Wolf-Dietrich (Univ., Goettingen, Ger.). Z. Phys.; 238: 130-9(1970). (In German).

The scintillation response of anthracene crystals to protons in the energy range 200 to 600 keV was investigated as a function of angle of incidence with respect to the crystal axes. Small local minima of the scintillation response occurred, when the protons were incident along the directions [001] = c, [102] and [101]. A detailed investigation showed a small maximum within the local minimum of the scintillation response, when the protons were incident along the c-direction. The observed effects are interpreted as channeling and blocking effects. (auth)

46559 RADIATION RESISTANT SEMICONDUCTOR DEVICE AND METHOD. James, Brian David (to Signetics Corp.). U. S. Patent 3,518,494. 30 Jun 1970. Filed 29 Jun 1964.

A method for rendering a semiconductor device resistant to ionization by radiation is described. A thin dielectric layer is deposited on the device, and then a thin metal layer is deposited on the dielectric layer. (W.H.K.)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 46248.

Basic Processes

Refer also to abstract 46402.

46560 METHODS OF OBTAINING A MONOGRANULAR PHOTOLAYER FOR THE PURPOSES OF ELECTRON MICROSCOPIC RADIOAUTOGRAPY. Paukov, V. S.; Heilmann, K.; Wegener, K. (Moscow Medical Inst. Univ., Heidelberg). Arkh. Patol.; 32: 82-6(1970). (In Russian).

A comparative investigation of Ilford-L4 and Gevert NUC-307 photographic emulsions was performed for the purposes of estimating their applicability to electron microscopic radioautography and the use of Ilford-L4 and Gevert NUC-307 photographic emulsion was recommended. The method of obtaining a monogranular layer of photographic emulsion and concomitant errors are described in detail. A wire loop technique was employed. A golden zone appearing at the top of the loop is believed to be the indication of a good monogranular layer formation. (auth)

46561 USE OF HEMOGLOBIN AS A BIOLOGICAL MARKER. Vulpis, G. (CNEN, Rome). Biochim. Biol. Sper.; 7: 137-44 (1968). (In Italian). (TR/BIO(69)21)).

Techniques were compared to determine the most sensitive method of detecting and defining the hemoglobin utilized as a biological marker in x-irradiated mouse systems. Acrylamide gel electrophoresis was more sensitive and gave better resolution of the hemoglobin than the other techniques employed. (auth)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 46613 and 46673.

46562 ACTIVATION OF ^{32}P-INCORPORATION INTO NUCLEOTIDES OF THYMUS NUCLEI BY BASES AND RIBONUCLEOSIDES. Dancheva, K. I. (High Medical School, Sofia). Vop. Med. Khim.; 16: 38-42(Jan-Feb 1970). (In Russian).

Ribonucleosides and bases activate ^{32}P-incorporation into nucleotides of thymus nuclei. Ribonucleosides participate in phosphorylation as well as in energy-delivering reactions. Purine bases activate phosphorylation more intensively as compared to the pyrimidines. (auth)

46563 METHOD FOR MEASURING RADIOIODINE UPTAKE WHICH CORRECTS FOR THYROID DEPTH. Schulz, A. G.; Rollo, F. D. (Johns Hopkins Medical Institutions, Baltimore. Johns Hopkins Univ., Silver Spring, Md.). J. Nucl. Med.; 11: 508-13 (Aug 1970).

A method was presented for measuring radioiodine uptake by the thyroid based on counting rate measurements made at two prescribed distances from the subject. The approach is simple and can be applied to any standard thyroid uptake system providing calibration curves are made for the system using a variable depth phantom such as that described in the text. The technique provides measurements that are corrected for variations in the depth of the gland, distance from the detector to the organ, and tissue scattering and attenuation. A series of phantom experiments show the method to be both reliable and accurate. Clinical studies on 91 patients show that variations in thyroid depth cause apparent inaccuracies in uptake measurements when made using a standard phantom, thereby indicating the importance of correcting for variation in organ depth. Because the two-distance method compensates for variations due to thyroid-detector distances, an obvious extension of the method presented would be the use of a decreased organ-detector distance in uptake measurements. This would result in an increased sensitivity that might be used to decrease the administered radionuclide dose. The method corrects for the effects of attenuation and scattering that vary with the depth of the gland. Consequently, the method permits the use of low-energy radioisotopes where these effects have been especially critical. The results of phantom studies with ^{125}I verify this application of a low-energy radioisotope. (auth)

46564 PLANT UPTAKE OF FISSION PRODUCTS. I. UPTAKE OF ^{90}Sr IN POT EXPERIMENTS IN RELATION TO UPTAKE UNDER FIELD CONDITIONS. Fredriksson, L.; Eriksson, Aa. (Lantbrukshogskolan, Uppsala). Lantbrukshogsk. Ann.; 36: 3-18 (1970).

Data are given on root uptake of ^{90}Sr by plants, when grown in pot experiments, from four Swedish soils differing in various properties. The plants studied were cereals, potatoes, vegetables, rootcrops, hay, and straw. The content of exchangeable calcium, the degree of calcium base saturation, and the total base exchange capacity were the main soil chemical properties influencing root uptake of ^{90}Sr. The plants seemed to absorb Sr and Ca in proportion to their relative concentrations in the soil solution. No differences between different plant species were observed in this respect. From this, it follows that plants such as legumes, which absorb more Ca than, for instance, gramineous plants, will also absorb more Sr. Due to differences in transport of Ca and Sr inside the plant, the ratio between Sr and Ca may, however, vary in different organs of the same plant. (vdk) (SW)

46565 EFFECT OF ZINC DEFICIENCY ON ^{35}S AND HEXOSAMINE METABOLISM IN THE EPIPHYSEAL PLATE AND PRIMARY SPONGIOSA OF THE CHICK. Nielsen, Forest H.; Dowdy, Richard P.; Ziporin, Zigmund Z. (Fitzsimons General Hospital, Denver). J. Nutr.; 100: 903-8(Aug 1970).

The objective of this study was to ascertain whether or not the zinc status of the chick has an effect on sulfate–sulfur metabolism in the bone elongation region of the tibia. Studies were conducted in which 10 μCi of $^{35}SO_4^{=}$ were given either orally or intraperitoneally to chicks that had been fed for 4 weeks either a zinc-deficient (14 ppm) or a zinc-sufficient (90 ppm) purified diet based upon soy protein and glucose. The zinc-sufficient chicks were divided into two groups: ad libitum-fed, and restricted-fed so that their average weight gain was approximately equal to that of the zinc-deficient chicks. At 6, 12, 24, 48, and 96 hr following isotope administration, five birds from each group were killed; the epiphyseal plate through the hypertrophic zone and the primary spongiosa of the tibias were removed and analyzed for ^{35}S content. The peak ^{35}S activity (dpm/mg fresh tissue) in those regions occurred approximately 12 hr following isotope administration by either method. Peak activity of the isotope was significantly less in the zinc-deficient chicks compared with either zinc-sufficient group. Hexosamine content per milligram fresh epiphyseal plate was not significantly altered by zinc deficiency. A significant increase in the hexosamine content of the primary spongiosa was noted under conditions of zinc deficiency. These results suggest that the metabolism of $SO_4^{=}$, an important constituent of mucopolysaccharide in bone elongation regions, is altered by zinc deficiency in the chick. (auth)

46566 EFFECTS OF HIGH BUT NONTOXIC LEVELS OF ZINC IN PRACTICAL DIETS ON ^{65}Zn AND ZINC METABOLISM IN HOLSTEIN CALVES. Miller, W. J.; Blackmon, D. M.; Gentry, R. P.; Pate, F. M. (Univ. of Georgia, Athens). J. Nutr.; 100: 893-902(Aug 1970).

Zinc and ^{65}Zn metabolism was studied in 16 Holstein bull calves fed a practical diet (33 ppm Zn) or the diet supplemented with 200 or 600 ppm zinc from zinc oxide or 600 ppm from zinc sulfate. None of the supplemental zinc treatments substantially affected zinc content of muscle, heart, tibia joint, tibia shaft, or testicle samples obtained 21 days after initiation of dietary treatments. Even though 233 ppm zinc caused large increases in zinc content of pancreas and liver, 633 ppm resulted in increases many times as great. High zinc diets decreased ^{65}Zn absorption. Thus, high zinc diets decreased the proportion while increasing the total amount of zinc absorbed. In all tissues studied, feeding the 233 ppm diet reduced ^{65}Zn content 14 days after a single oral dose. In contrast, increasing dietary zinc from 233 to 633 ppm greatly increased ^{65}Zn accumulation in liver, pancreas, and kidney. The ^{65}Zn and stable zinc data indicated that some control mechanism that limited zinc build-up was overcome with the 633 ppm diet in these tissues but not in many others. Zinc oxide and zinc sulfate had comparable effects on zinc levels in most tissues. Relative to zinc oxide, zinc sulfate tended to reduce ^{65}Zn content of most tissues and to increase endogenous ^{65}Zn excretion. (auth)

46567 EFFECTS OF DIETARY ZINC AND CALCIUM ON THE RETENTION AND DISTRIBUTION OF ZINC IN RATS FED SEMIPURIFIED DIETS. Huber, Agnes M.; Gershoff, Stanley N. (Harvard School of Public Health, Boston). J. Nutr.; 100: 949-54(Aug 1970).

The effects of feeding rats semipurified diets containing deficient (1 to 6 ppm), control (15 to 16.3 ppm), and high (1550 ppm) levels of zinc and 0.6 or 1.3% calcium on the retention and distribution of zinc were studied. The retention of ^{65}Zn, whether

administered orally or intraperitoneally, was directly related to the levels of zinc fed. Zinc loss was primarily in the feces. The high calcium diet markedly decreased ^{65}Zn absorption in rats fed a zinc-deficient diet but not in those fed a control diet. However, the high calcium level had no significant effect on the retention or distribution in the tissues studied of ^{65}Zn injected intraperitoneally. In zinc-deficient rats, the greatest effect on zinc content was in the femur and hair. When the high zinc diet was fed, significant increases in zinc levels were observed in most tissues studied, the largest increase being in the pancreas. (auth)

46568 RADIATION EFFECT FROM METABOLISM OF TRITIATED THYMIDINE. Van de Riet, William G.; Shaw, Edward I. (Univ. of Kansas, Lawrence). Radiat. Res.; 43: 416-28(Aug 1970).

The effect of the number of micromoles of thymidine on the metabolism of tracer quantities of $^{3}HTdR$ was studied in mice after oral administration of 1.0 μCi of tritium incorporated into different amounts of thymidine. The quantity of nonvolatile radioactivity in tissues versus time suggested the presence of tritium in two very different metabolic components. Early labeling of tissue was in proportion to the amount of thymidine administered. Time studies revealed that increases in the total quantity of thymidine (lower specific activity $^{3}HTdR$) administered led to a higher fraction of radioactive tracer label in the more stable component of tissue activity. Radiation effects were detected by comparing the retention of label following administration of 1.0 and 8.3 μCi of $^{3}HTdR$ in the same number of micromoles of thymidine. When 8.3 μCi was administered, a rather rapid rate of decline of activity was observed in the component of tissue activity in which the tracer label is usually very stable. Thus, a radiation effect is present when $^{3}HTdR$ is administered to mice in an amount as low as 0.3 μCi per gram body weight. (auth)

46569 RADIOIODINE INDUCED THYROID TUMOURS IN THE INDIAN FRESHWATER CAT-FISH MYSTUS VITTATUS (BLOCH.). Sathyanesan, A. G.; Srivastava, S. S. (Banaras Hindu Univ., India). Curr. Sci. (India); 39: 350-1(5 Aug 1970).

Six adult freshwater catfish (Mystus vittatus) were injected i.p. with 1 mCi of ^{131}I in a single dose or fractionated over a 4-month period. One of the fish receiving fractionated doses exhibited several cystic tumors of the thyroid after 8 months. In the remaining fish, epithelial cell replacement by connective tissue was noted from the second month on, but no tumors appeared. Autoradiographic results indicated that a major portion of the gland was completely destroyed. (E.R.B.)

46570 ^{51}Cr DISTRIBUTION IN TISSUES AND EXTRACTS OF LEPTOSPERMUM SCOPARIUM. Lyon, G. L.; Peterson, P. J.; Brooks, R. R. (Massey Univ., Palmerston North, N. Z.). Planta; 88: 282-7(1969).

Leptospermum scoparium plants cultured in solutions containing $Na_2{}^{51}CrO_4$ accumulated most of the absorbed radioactivity in the roots. About one third of the root radioactivity was soluble in 80% ethanol in the form of three ^{51}Cr-complexes, the predominant one being identified as trioxalatochromate (III) ion. These complexes were also present in stem and leaf extracts. Chromium-51 distribution was examined in various chemical fractions; protein and nucleic acids were especially low in radioactivity. (auth)

46571 PHYSICAL HALF LIFE OF RADIOCHEMICALLY PURE (>99.9999%) ^{59}Fe AND ITS METABOLIC TURNOVER RATE IN MAN. Heinrich, H. C.; Gabbe, E. E. (Univ., Hamburg). Experientia; 26: 467-8(15 May 1970).

Following the preparation of ^{59}Fe by anion exchange chromatography and the determination of its radiochemical purity (99.9999%), measurements were made of the physical, effective, and biological half-lives of the radioisotope in males and menstruating females. These results (44.52, 43.6, 2190 and 44.52, 43.1, and 1340, respectively) were compared to those obtained in the literature for commercially pure (99%) ^{59}Fe preparations. Whole-body iron turnover rates were then calculated from the measured physical and effective half-lives of absorbed radiochemically pure ^{59}Fe. The results indicate a daily turnover or requirement of about 1.2 mg in males and 1.4 mg in females. (E.R.B.)

46572 INCORPORATION OF ^{14}C FROM RADIOACTIVE ACETATE INTO TISSUES AND COMPONENTS OF TISSUES IN HENS OF DIFFERENT AGE GROUPS. Sushkova, V. V.; Gulii, M. F. (Inst. of Biochemistry, Kiev). Ukr. Biokhim. Zh.; 42: 102-7(1970). (In Ukrainian).

The dynamics was studied of ^{14}C incorporation from sodium acetate into proteins of liver, lipids, and glycogen of the liver and muscles, into proteins of blood serum as well as into tissue of the myocardium and pectoralis in cocks of different age. Radioactivity was determined 30, 60, 90, and 120 min (in some cases 40 min) after introducing the isotope indicator. It is shown that incorporation and excretion of the radioactive label in chickens proceeds quicker than in adult hens. Maximum of ^{14}C incorporation into proteins, lipids, and glycogen of liver in chickens begins in 40 min after introducing 2-^{14}C acetate and in cocks at the age of 18 months in 1.5 hrs. In hens of the same age incorporation of ^{14}C into the myocardium occurs more intensively and quicker than in pectoralis. With age the intensity of label incorporation into tissues and components of tissues lowers in hens. The sharpest difference in ^{14}C incorporation with age is observed in 30 min after labeling. The lowering in the intensity of the label incorporation into proteins, lipids, and glycogen of the liver is particularly pronounced when comparing groups of 1 to 3 and 6 to 18 month cocks. Significant differences are not found between the values of specific radioactivity of proteins, lipids, and glycogen of the liver in 6- and 18-month cocks. (auth)

46573 STUDIES ON THE IN VIVO BREAKDOWN OF INSOLUBLE HALIDES. Anghileri, Leopoldo J. (Johns Hopkins Medical Institutions, Baltimore). Acta Isotop.; 9: 347-56 (30 Sep 1969).

Silver iodide, silver bromide, and palladous iodide have shown a remarkable instability in vivo. Using these halides labeled with either ^{110}Ag, ^{131}I or ^{125}I, and ^{82}Br, the tissue distribution, as well as the rate of excretion, was studied. All the halides were broken down rapidly. Radiosilver was released as a non-ionic form that is excreted through the bile. Radioiodine was eliminated at a faster rate than radiobromine, which remained in the blood longer. (auth)

46574 EFFECT OF PHOTOPHOSPHORYLATION INHIBITORS ON ^{14}C METABOLISM IN CHLORELLA. Glagoleva, T. A.; Muuk, E. L.; Ivanova, N. A. (Botanical Inst., Leningrad). Bot. Zh.; No. 12, 1965-73(1969). (In Russian).

Cyclic and noncyclic photophosphorylation was blocked in cultures of Chlorella pyrenoidosa Chick, strain 82, with antimycin A and DCMU [3-(3,4-dichlorophenyl)-1,1-dimethylurea], respectively. The inhibitors caused similar changes in the metabolism of ^{14}C. The extent of change varied not so much with the specific nature of the inhibitor as with the degree of suppression of intensity of photosynthesis. The reactions leading to the formation of starch from sugar monophosphates were the most sensitive link in the process. When the intensity of photosynthesis was suppressed by 30 to 40%, the early stages in the carbon reduction cycle were less affected. Another feature of ^{14}C metabolism in algae under the influence of the inhibitors was accumulation of labeled carbon in alanine, apparently due to blocking of the outflow of ^{14}C from this amino acid. Several explanations are offered to account for the similarity of the effect of the inhibitors of cyclic and noncyclic photophosphorylation. (JPRS)

46575 VARIATIONS IN LIPID METABOLISM AS THE BASIS OF A TOLERANCE TEST AFTER LONG-TERM RADIATION EXPOSURE. Adamek, M. (Inst. of National Health of the Uranium Industry, Pribram, Czech.); Roth, K.; Stepankova, M. Krebsarzt; 24: 306-11(1969). (In German).

An individual tolerance test for uranium miners is described. The test permits for the time being a differentiation of the miners into two groups: the first group where an adaptation to radon radiation in the working environment develops in a normal manner and the second group where no regular adaptation can be found. For this last group more precaution is necessary than for the first group for which the normal preventive provisions should be sufficient. (auth)

Radiation Effects

Refer also to abstract 46615.

46576 EFFECTS OF IRRADIATION ON THE GENERATIVE CYCLE OF THE ESTROGEN STIMULATED VAGINAL EPITHELIUM. Ladinsky, J. L.; Gruchow, H. W. (Univ. of Wisconsin, Madison). Cell Tissue Kinet; 3: 175-84(Apr 1970).

The effects of γ irradiation (300, 500, and 1500 rads) on mitosis and DNA synthesis in the estrogen primed vaginal epithelium were studied. Dose-effect relations and the time sequence of effects on the two processes were investigated. The technique of tritiated-thymidine labeling of DNA with autoradiography was used, in conjunction with the mitotic count, to study alterations in the generative cycle. Prior to irradiation, ovariectomized female rats were treated daily with diethylstilbestrol for a period of 2 weeks to create a steady state in the vaginal cell population. It was observed that: Within 1 hr following ionizing radiation, mitotic figures disappear from the population and reappear at a time that is dose dependent. Those cells that have begun mitosis at the time of irradi-

ation were able to complete that phase but no cells that were in G_2 were able to begin mitosis. Therefore, a G_2 block occurs within 1 hr post-irradiation. Radiation reduces the rate of DNA synthesis thus prolonging the S phase. There is no evidence of a radiation-induced G_1 to S block in this system. Based on these observations, it was further hypothesized that: Cells in G_1 at the time of irradiation are relatively insensitive and continue to progress through the generative cycle at a rate primarily determined by the level of estrogen stimulation. Radiation may interfere with the estrogen priming mechanism in this hormone-dependent system thereby reducing the effective level of estrogen stimulation. This is seen in the behavior of cells that were in G_1 at the time of irradiation. The extent of the blockage of estrogen increases with radiation dose and after 1500 rads, estrogen stimulation is essentially at castrate level. (auth)

46577 EFFECT OF γ RADIATION ON POLYSACCHARIDES AND CALCIUM DISTRIBUTION IN CARROT CELL WALLS. Echandi, Ronald J.; Chase, Betty R.; Massey, Louis M. Jr. (Cornell Univ., Geneva, N. Y.). J. Agr. Food Chem.; 18: 878-80(Sep-Oct 1970).

Vegetable foods are drastically softened by high doses of γ radiation. Irradiated plant tissues also leach calcium that has been associated with this softening. To investigate the relation of this calcium to cell wall polysaccharide degradation, irradiated carrots were fractionated into their constituent polysaccharides and analyzed for calcium. Irradiation brought about a redistribution of cell wall polysaccharides that is generally consistent with solubilization. Calcium was associated with the most insoluble polysaccharide fraction. It was concluded that the observed release of calcium is either not associated with the cell wall or is associated only with the weakly bound calcium and probably not in itself responsible for the softening process. (auth)

46578 RADIATION EFFECTS ON PECTINASE SOLUTIONS. Pansolli, P. (CNEN, Rome). Experientia; 26: 499-500(15 May 1970).

Aqueous solutions of pectinase were x-irradiated in Petri dishes at doses of 0.5 and 1.0 Mrad for all concentrations and 1, 10, 50, 200, and 500 Krad and 1 Mrad for 1.5×10^{-4} M solutions. The results indicate that at doses as low as 1.0 Krad, the enzyme is still radiosensitive and this sensitivity increases exponentially until 200 Krad, tending, afterwards, to asymptote. A new method is described for determining pectinase activity. (E.R.B.)

46579 EFFECT OF RADIATION ON THE ACTIVITY OF LEUCYL DIPEPTIDASE. Chang, Shuh-ming. Bull. Inst. Chem., Acad. Sinica; No. 17, 51-60(Apr 1970).

The effects of x rays, ^{60}Co γ ray and uv irradiation on the leucyl dipeptidase activity of acetone powder preparation of Actinomucor elegans toward leucyl-leucine, leucyl-glycine, and leucinamide were investigated. The hydrolysis activity was estimated by the use of ninhydrin-citrate-glycerol as the color reagent. The leucyl dipeptidases in dilute solution as well as in dry state were deactivated by the radiation from ^{60}Co and x rays. Leucylglycine dipeptidase was liable to be affected by uv irradiation. Cu^{2+}, Fe^{3+}, and Mn^{2+} were shown to be protective for the enzymes after irradiations while other ions such as Ca^{2+}, Co^{2+}, and Zn^{2+} had no significant effects. (auth)

46580 ELECTRON SPIN RESONANCE STUDIES OF IRRADIATED NUCLEIC ACID AND NUCLEIC ACID-CYSTEAMINE SYSTEMS. Milvy, Paul; Farcasiu, Malvina (City Coll., New York). Radiat. Res.; 43: 320-31(Aug 1970).

Electron spin resonance studies were performed on systems of DNA and β-mercaptoethylamine (cysteamine). The samples were studied after lyophilization and were exposed to x rays and observed in the spectrometer at near liquid nitrogen temperatures. Spectra were recorded at this temperature and after the samples were annealed. The transfer of free radicals from the DNA to cysteamine as a function of cysteamine content, pH, and pyrimidine content of the DNA was studied. The following general observations were made. The number of spins transferred per cysteamine molecule remained constant in the DNA-cysteamine system when 8.5% or less cysteamine was added. The transfer was also observed to be a linear function of the thymine content of partially depyrimidinated DNA. These results permitted an estimate to be made of the migration range of those DNA free radicals that ultimately were transferred to the thiol. Lowering the pH of the system reduced the transfer of spins to cysteamine. The effect of pH on the intramolecular migration of spins in DNA samples was studied. It was observed that as the pH was lowered, the annealed spectrum became increasingly similar to the spectrum of irradiated thymine. At pH $\leq$ 2.0 the samples carbonized during lyophilization and stable free radicals were observed in the unirradiated samples. (auth)

46581 LOSS OF ELECTROLYTES AND AMINO ACIDS FROM GAMMA-IRRADIATED CARROTS. Echandi, R. J.; Massey, L. M. Jr. (New York State Agricultural Experiment Station, Geneva). Contract AT(30-1)-3274. Radiat. Res.; 43: 372-8(Aug 1970). (NYO-3274-15).

The loss of electrolytes and amino acids from γ-irradiated carrot tissues to an aqueous medium was found to be both dose and dose-rate dependent. Calcium was the cation most readily leached, followed by copper, zinc, sodium, phosphorus, boron, iron, aluminum, manganese. The rate of amino acid loss was extensive at doses above 500 krads. Aspartic acid was the amino acid most readily leached. (auth)

46582 RNA POLYMERASE ACTIVITY IN LIVER NUCLEI OF INTACT AND ADRENALECTOMIZED γ-IRRADIATED MICE. Yatvin, M. B. (Univ. of Wisconsin, Madison). Experientia; 26: 490(15May 1970).

The activity of RNA polymerase in the liver of intact and adrenalectomized mice was determined following whole-body ^{137}Cs γ irradiation at a dose of 10,000 R delivered at 1800 R/min. In the intact mice, the RNA polymerase activity increased following irradiation reaching a peak activity 100% above controls at 6 hr postirradiation. At 18 hr postirradiation, activity levels were still elevated. In the adrenalectomized animals activity levels were not elevated, but were, in fact, decreased over the same time period following irradiation. (E.R.B.)

46583 EFFECT OF LASER PHOTOCOAGULATION ON THE PROTEIN CONTENT OF THE VITREOUS FLUID. Nastri, G.; Sbordone, G.; Sbordone, M.; Caccia Perugini, G. (Univ., Naples). Minerva Oftalmol.; 10: 153-5(Sep-Oct 1968). (In Italian).

After a brief survey of the literature, the results of photocoagulation of the retina with a laser on the protein content of the aqueous fluid in rabbits are presented. (auth)

46584 EFFECT OF LASER PHOTOCOAGULATION ON THE ELECTROLYTE CONTENT OF THE OCULAR FLUIDS. Sbordone, G.; Sbordone, M.; Nastri, G. (Univ., Naples). Minerva Oftalmol.; 10: 161-2(Sep-Oct 1968). (In Italian).

The variations of the sodium and potassium contents of the vitreous and aqueous fluids in rabbits subjected to photocoagulation with a laser were investigated. (auth)

46585 DOSIMETRY FOR NEUTRON IRRADIATION OF TWO CYTOSTATICS. Szirmai, E.; Knapp, J.; Royl, P. (Univ., Stuttgart). Schweiz. Med. Wochensch.; 100: 319-20(14 Feb 1970). (In German).

The cytostatics Trenimon and Myelobromol and a new combination of two important amino acids, Hepamerz, were irradiated with neutrons in the Siemens Training Reactor SUR 100. The irradiation time was 1 h and reactor power was 100 mW. After irradiation the dose rates were measured. For Trenimon the $\beta + \gamma$ dose rate was in the order of magnitude of the background. The dose rate for Hepamerz was some three times higher, and that for Myelobromol approximately 4000 times higher, than the natural background. The chemical composition of Trenimon and Myelobromol and the activation cross sections make it possible to explain these differences qualitatively. A complete theoretical interpretation is impossible as the chemical formulas of some components of the preparations are unknown. (auth)

46586 RADIATION-INDUCED RADICALS IN THYMIDINE SINGLE CRYSTALS AT 77°K. Snipes, Wallace; Henriksen, Thormod (Univ. of California, Berkeley). Int. J. Radiat. Biol.; 17: 367-73(1970).

Three different free radicals are formed in detectable quantities in thymidine single crystals irradiated at 77°K. In addition to the spectrum of the previously known 5,6-dihydrothymidin-5-yl radical, a quartet resonance and a doublet resonance are observed. The quartet resonance is attributed to the 5,6-dihydrothymidin-6-yl radical, but the exact nature of the radical giving the doublet remains speculative. (auth) (UK)

46587 RESISTANCE OF DNA AGAINST RADIATION-INDUCED STRAND BREAKAGE IN BACTERIAL SPORES. Tanooka, Hiroshi (National Cancer Center Research Inst., Tokyo); Terano, Hiroshi. Radiat. Res.; 43: 613-26(Sep 1970).

Single- and double-strand breaks of DNA in electron-irradiated Bacillus subtilis spores were measured and compared with those in irradiated vegetative cells by zone sedimentation in alkaline and neutral pH sucrose gradients. DNA in spores was much more resistant to both types of damage than DNA in vegetative cells. Induction of one single-strand break in DNA of spore genome required 2.8 krad compared to 0.13 krad in vegetative cell genome. In other terms, energies of 857 eV in spore DNA and 41 eV in vegetative cell DNA were required to induce one single-strand break, calculated from molecular weights given by weight-average sedimentation distances; or 835 eV and 46 eV, calculated

from weight-average molecular weights. The resistance of DNA was maintained after spores were converted to osmotically sensitive spheroplasts; however, the resistance was lost by rupture of the spheroplast structure. This resistance of DNA was not due to the repair activity of spores nor to protective substance in spore coat and cortex. Structural integrity of DNA is considered to be most important in protection of DNA in spores. According to calculations based on the target theory, the idea that one double-strand break in DNA of genome corresponds to one lethal hit seems to be valid in spores and vegetative cells. (auth)

46588 X- AND γ-IRRADIATION OF DILUTE SOLUTIONS OF CHYMOTRYPSIN IN ATMOSPHERES OF AIR AND NITROGEN: EFFECTS ON ACTIVITY TOWARDS VARIOUS SUBSTRATES. Lynn, K. R. (National Research Council of Canada, Ottawa). Radiat. Res.; 43: 525-33(Sep 1970).

A correlation observed between loss of tryptophan and loss of reactivity to N-benzoyl tyrosine ethyl ester following irradiation of dilute solutions of chymotrypsin in both air and nitrogen atmospheres is not general for all synthetic substrates. The loss of activity by the enzyme on irradiation with x and γ rays was measured using nine synthetic substrates including both esters and amides. It was found that the D_{37} observed was a function of the substrate employed, and parallel results were obtained from irradiations in air and in nitrogen. Oxygen was protective. (auth)

46589 ELECTRON PARAMAGNETIC RESONANCE STUDY OF WOOL IRRADIATED BY ULTRAVIOLET AND VISIBLE LIGHT. Shatkay, A.; Michaeli, I. (Weizmann Inst. of Science, Rehovot, Israel). Radiat. Res.; 43: 485-98(Sep 1970).

Natural wool was irradiated with uv and visible light, and the effects of dose, time, and atmosphere on the electron paramagnetic resonance spectra were studied. The results support the view that a complex radical population is created by low energy radiation, and that both during the irradiation and after its cessation the total concentration of the radicals and the ratios of the different species are changing with time. It was found that at sufficiently low intensities the signal associated with sulfur did not appear even after prolonged times of exposure, while the development of the signal not associated with sulfur was similar to that found under stronger illumination. The dependence of the above-mentioned two types of signals on time of high intensity irradiation was studied over prolonged periods. It was found that while the sulfur signal appears to approach saturation, the other signal passes through a maximum. Significantly different effects were observed when the experiments were conducted in atmospheres of nitrogen, oxygen, or pure water vapor. (auth)

Immunology

Refer also to abstract 46647.

46590 COMPARATIVE STUDY OF THE REPOPULATING POTENTIAL OF GRAFTS FROM VARIOUS HAEMOPOIETIC SOURCES: CFU REPOPULATION. Schofield, R. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Cell Tissue Kinet; 3: 119-30(Apr 1970).

The growth rate of the CFU populations in spleens and femors was studied in lethally x-irradiated mice injected with cell suspensions, containing equivalent number of CFU, from various sources. The doubling times are shown to be dependent upon the source of the cells. Grafts of bone marrow, spleen, and fetal liver cells produced doubling times in the spleen of approximately 25, 19, and 16 hr respectively. Grafts of marrow-derived and spleen-derived spleen colony cells both gave rise to CFU doubling times lower than those of the corresponding primary grafts (approx. 33 and 26 hr respectively in the spleen). In the case of both bone marrow and spleen grafts the CFU population growth was shown to be independent of the size of the graft. A hypothesis is advanced that invokes at least a dual population of CFU, having different doubling times, different seeding capacities in the hemopoietic tissues following i.v. injection and present in different proportions in the various hemopoietic tissues. (auth)

46591 OSTEOGENESIS AND REVITALIZATION IN EXPERIMENTAL MARROW DEPRESSION BY AN ALLOGENIC MARROW TRANSFER VEHICLE. Amler, Melvin H. (New York Univ., N. Y.). Exp. Med. Surg.; 27: 316-24(1969).

A preliminary study of the use of a plastic sponge vehicle for transfering allogenic marrow for osteogenesis and revitalization in marrow depression following whole-body x irradiation was completed. It is thought the reason tissue sections indicated a tolerance of implanted tissue, even in hosts that had received irradiation doses of less than the LD 50, could have been due to incomplete development of antigenic challenging factors in the respective donor marrows utilized in the allografts. It is also thought that use of a vehicle, such as a plastic sponge for experimental marrow allografts could represent an improvement by replacement, or by concomitant utilization, over the present technique of marrow aspiration. While marrow infusion can be useful as a palliative treatment, the vehicle marrow transfer could serve as a reservoir of new cells over a longer period of time. (auth)

Ecology

Refer also to abstract 46564 and 46681.

46592 (SZS-10/70) CONFERENCE OF THE GERMAN-POLISH WORK GROUP FOR THE SURVEILLANCE OF THE RADIOACTIVE CONTAMINATION OF THE ENVIRONMENT, BERLIN, JUNE 16-21, 1969. PART II, 1. Moldenhawer, F.; Bose, H.; Korsetz, B. (comps.) (Staatliche Zentrale fuer Strahlenschutz, Berlin (East Germany)). May 1970. 46p. (In German). Dep. CFSTI (U. S. Sales Only).

Measurements of artificial radioactivity in the atmosphere were reported for the year 1968 in the DDR and were compiled in three graphs and two tables. Also discussed were contamination levels in surface waters. The Elbe River with its tributaries was found to be the most important within the river system. It was concluded that contamination from fallout was far below the levels endangering drinking water supplies. For the year 1968, results of fallout monitoring for soil and plants were compiled in five tables with respect to various isotopes. Radioactive environmental contamination in Poland from 1962 to 1968 was studied for air, precipitation, surface water, soil, and farm products. Results were presented in fifteen diagrams and three tables. (H.B.G.)

46593 (TID-4065) SUMMARIES OF USAEC ENVIRONMENTAL RESEARCH AND DEVELOPMENT. (Division of Biology and Medicine (AEC), Washington, D. C. Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Sep 1970. 282p. Dep. CFSTI.

Indexes prepared by Division of Technical Information Extension (AEC), Oak Ridge, Tenn.

Summaries of current environmental research and development funded by various divisions of the AEC are presented. The 1072 summaries are organized into the following catagories: transport and fate (of radioisotopes in the natural environment); measuring and monitoring (instrumentation and techniques for determining radiation exposures to man); evaluation of effects (both human health and safety and natural populations and species); and prevention and control technology (for handling, collection, treatment, and disposal of radioactive waste materials and effluents from the nuclear energy industry). Also included in the publication are contractor, principal investigator, and subject indexes. (E.R.B.)

46594 SOME ASPECTS OF ENVIRONMENTAL RADIOACTIVITY RESEARCH. Gigna, A. A. (CNEN-CSN, Rome). Arh. Hig. Rada Toksikol.; 20: 25-38(1969).

The differences between the situation before and after the moratorium of nuclear tests in 1962 are analyzed. Such differences led to different approaches to the problem of radioactive environmental contamination. The representativity of the measurements is discussed from the point of view of both the time and the site of sampling. Due to either the low level or the absence of radioactive contamination, the actual trend to the research concerns the study of the distribution patterns and the behavior of stable elements in the biosphere. Different methods of analysis are considered and a survey into the capacity of each of them is presented. The contribution of the ecological research in the field of radiation protection is discussed. Some indicators are well known by many researchers and proved to be valuable in the early detection of environmental contamination. The problem of the determination of the concentration factors is also considered. They play an important role in the establishment of the ecocycles of the radionuclides (fission and activation products) produced by nuclear power and research plants. The reference levels of radioactive contamination in the items of the food-chain can be determined taking into account both the concentration processes involved and the specific activity. The advantages of the different approaches are reported and discussed. The change in the radiation protection philosophy reported in the ICRP publication No. 7 is considered with its consequences in the development of health physics techniques around nuclear plants. (auth)

46595 ASPECTS OF INDUSTRIAL POLLUTION. Urrutia, Jose Llado Fernandez. Rev. Sanid. Hig. Publica; 43: 663-713 (Sep-Oct 1969). (In Spanish).

The irreversibility of the industrialization process, the increase of industrial demand for water, and the rise in industrial water pollution are analyzed. The causes of contamination in fluvial and subterraneous waters were studied. The foreign and Spanish legislation to prevent pollution of continental waters is reviewed, and the contamination of marine waters is studied in detail. The atmospheric contamination from different sources and the Spanish legislation for these problems are given, and conclusions concerning these problems are discussed. (auth)

46596 BIBLIOGRAPHIES IN NUCLEAR SCIENCE AND TECHNOLOGY, NO. 10, APRIL 1970. CONTAMINATION AND DECONTAMINATION OF FOOD. Beising, K. (Comp.). Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 72p. (AED-C-02-10).

Three-hundred and fifty seven references are presented to world literature between 1961 and 1968 on radioisotope content of food and removal procedures in various geographical locations. Author index and subject index are included. (H.B.G.)

Genetics and Cytogenetics

Refer also to abstracts 46593, 46609, and 46669.

46597 (LIB/Trans-263) CYTOGENETIC STUDIES ON SUBJECTS WITH OCCUPATIONAL EXPOSURE TO SMALL DOSES OF IONIZING RADIATIONS. Forni, A.; Ghezzi, I.; Cappellini, A. Translated by E. Montileane (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from Med. Lavoro; 60: 169-74(Mar 1969). 17p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 23: 41287 (1969). (Australia)

46598 (LIB/Trans-274) CHROMOSOMES AND RADIATIONS. Roget, J.; Jobert, J. Translated by P. J. F. Newton (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from J. Med. Bordeaux; 144: 149-59(Jan 1967). 24p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 23: 47970. (Australia)

46599 (NP-18164) TECHNICAL INFORMATION, JULY 1, 1968-JUNE 30, 1969. (Inter-American Inst. of Agricultural Sciences, San Jose (Costa Rica)). 1970. 479p. (In Spanish). Dep. CFSTI (U. S. Sales Only).

The accomplishments in the upgrading of the agricultural educational institutions, agricultural research institutions, and rural development and agricultural reform under the auspices of the Inter-American Institution of Agricultural Sciences are reported. (J.S.R.)

46600 LAMBDA PHAGE MUTANTS INSENSITIVE TO TEMPERATURE-SENSITIVE REPRESSOR. II. GENETIC CHARACTER of λvirC MUTANT. Koga, Hideo; Miyauchi, Teruo; Horiuchi, Tadao (Kyushu Univ., Fujkuoka). Mol. Gen. Genet.; 106: 114-22 (1970).

The isolation of λ recombinant carrying virC mutation from newly isolated λ virulent carrying virL virC virR (Horiuchi et al., 1969) was succeeded and the genetic character of virC mutation producing clear plaque was studied. λ virL virC shows weak-virulent character and produces clear plaque on λCIts lysogen but not on wild type λ lysogen. λ virC shows a virulent character and no plaque is produced on these lysogen. The virC mutation is located very closely to and on the left side of the virR region which is presumed to be the operator of the right-side operon including O and P cistrons. The genetic characters of virL, virR and virC were compared with v_1, v_2, v_3 mutations of classical λ vir and c_{17} mutation of another type of λ virulent. The results indicate that virL, virC or virR mutation is similar to v_2, v_1 or v_3 mutation, respectively, and an effect of virC mutation on producing virulent character was somewhat similar to that of c_{17} mutation and was stronger than that of virR mutation. The length of virR region was suggested to be smaller than one tenth of that of the C1 cistron. (auth)

46601 EFFECT OF CHLORAMPHENICOL ON HOST-BACTERIOPHAGE RELATIONSHIPS IN THE LACTIC STREPTOCOCCI. Erskine, J. M. (New Zealand Dairy Research Inst., Palmerston North). Appl. Microbiol.; 19: 707-13(May 1970).

Chloramphenicol (CM)-resistant mutants of Streptococcus lactis strain ML3 were obtained either as a consequence of continuous transfer of the bacteria in broth containing increasing amounts of CM or by selecting for high-level resistant derivatives after mutagenic treatment of the bacteria. Some CM-resistant cells obtained by the first method were also resistant to the homologous bacteriophage. Cells trained to grow in the presence of CM developed resistance to some heterologous attacking phages but not to phage ml_2. Mutants selected for phage resistance were not resistant to CM. There appear to be two different loci for CM resistance on the bacterial chromosome: the one for high-level resistance is associated with the phage-resistance locus and the other is independent of it. A concentration of CM (280 μg/ml) that was bacteriostatic for ML3 inhibited the intracellular growth of ml_2 phage in strain ML3-CM^rI, that was trained to grow in the presence of that CM concentration, despite the fact that cells of this strain were not phage-resistant per se. The drug had no direct virucidal action and did not prevent adsorption to or penetration of phage into the bacterium. Lysogenization did not occur. It is concluded that the block in phage development probably involves inhibition of synthesis of phage components, either involving DNA at an early stage or the phage coat protein at a later one. (auth)

46602 TOMATO MUTANTS, USEFUL BREEDING CULTIVARS, AND HYBRIDS FOR MECHANICAL HARVESTING. Soressi, Gian Piero (Univ. Cattolica del Sacro, Piacenza, Italy. Istituto Sperimentale per l'Orticoltura, Salerno, Italy). Sementi Elette; 15: 76-81(Mar-Apr 1969). (In Italian).

In the perspective of outlining the ideal tomato plant suitable to mechanical harvesting, some spontaneous and artificially induced mutants are briefly described from the point of view of their inheritance and suitability for the synthesis of cultivars and hybrids. The mutant characters taken into consideration deal with the plant habit, fruit-resistance to overripeness, berry abscission, fruit color, seed-coat color, and structure. Successively, discussing in general the character of the hybrids, a scheme for hybrid seed production is suggested based on genetically marked lines with brown seed and spongy seed traits. These two seed characters permit utilization of natural cross-pollination together with mechanical and electronic separation of hybrid seed from the mixture of different seed type. (auth)

46603 ACTIDIONE-RESISTANT MUTANTS IN NEUROSPORA CRASSA. Neuhaeuser, Angelika; Klingmueller, Walter; Kaudewitz, Fritz (Univ., Munich). Mol. Gen. Genet.; 106: 180-94 (1970). (In German).

Conidia of an Actidione-sensitive wildtype strain of Neurospora crassa were irradiated with uv light. They were then plated into nutrient-agar, either with or without Actidione. The latter plates were incubated for several hrs before nutrient agar containing Actidione was layered onto the plates. Colonies formed in both sets of plates were isolated as Actidione-resistant. They were studied further by genetic and biochemical means. Pre-incubation of the irradiated conidia before subjecting them to the action of Actidione increased the mutant yield considerably, as compared to immediate plating with the drug. E.g., a 13 hr pre-incubation gave about 100 times more resistent colonies than were obtained without pre-incubation. Their resistent phenotype was stable on vegetative propagation. Seventeen mutants were mapped by crossing them with suitable tester-strains. Of them, 14 were found to belong to linkage group I_r the remaining to linkage group V. The mutants are, therefore, considered as characterizing resp. genes act-1 and -2 of Hsu (1963). Act-1 and -2 mutants were crossed with suitable auxotrophic strains to obtain auxotrophic, Actidione-resistent isolates. These were combined on minimal medium with auxotrophic, Actidione-sensitive strains of the same mating type. Conidia of the arising heterokaryotic mycelia were tested on minimal medium with and without Actidione. In these tests, resistance of act-1 and -2 mutants was found to be dominant over the sensitivity of the wildtype. However, an analysis of nuclear ratios in the conidial populations by differential plating does not exclude incomplete dominance of act-1. Incorporation of ^{14}C-leucine into protein of conidia of the wildtype was strongly inhibited by 1 γ Actidione/ml. Resistance in two mutants, representing the two separate genes, was accompanied by a marked decrease of this inhibition. No significant differences in the amount of inhibition were found between the two mutants. It is suggested that cytoplasmic ribosomes may be the cellular components influenced by Actidione. In the case of the mutant cells the Actidione is no longer effective in this capacity, possibly because of changes in the ribosomal proteins. (auth)

Health Physics and Safety

Refer also to abstract 46593.

Radioactive Contamination and Decontamination

Refer also to abstracts 46364, 46564, and 46594-46596.

46604 STUDIES ON DECONTAMINATION OF THE SURFACES OF VINIDUR, VINYLEUM, GLASS, STAINLESS STEEL,

AND RUBBER CONTAMINATED WITH ^{14}C-LABELLED ORGANIC COMPOUNDS. Smal, Zbigniew. Pr. Cent. Inst. Ochrony Pracy; 19: 299-320(1969). (In Polish).

Studies are described on the decontamination of the surfaces of vinidur, vinyleum, glass, stainless steel, and rubber contaminated with ^{14}C-labeled organic compounds, viz. glycine-1, d, l-valine-1, methanol, sodium formate, ethyl-1 acetate, and acetic-1 acid. The decontaminants investigated included: distilled water, tap water, aqueous solutions of sulphuric acid, sodium hydroxide and sodium carbonate, grain soap, and detergents (mirapol and FF); organic solvents, like anhydrous ethanol, acetone, tri, and tetra; and occasionally solutions of ferric chloride, zinc chloride, iodine in potassium iodide, orthophosphoric acid, and TBP in carbon tetrachloride. The degree of decontamination was found to be related to the type of contaminant, time of decontamination, and concentration of decontaminant. (auth)

46605 ACCUMULATION OF ^{90}Sr IN DECIDUOUS AND PERMANENT TEETH IN SLOVAKIA. Carach, J.; Csupka, S.; Petrasova, M.; Cechvala, L.; Sauberer, S. Bratislav. Lek. Listy; 53: 257-65(Mar 1970). (In Czech).

The content of ^{90}Sr was followed up in deciduous and permanent teeth in selected population groups in Slovakia. An indirect dependence of the ^{90}Sr content in deciduous and permanent teeth on the age of the followed up individuals was detected. The highest absolute rate of ^{90}Sr was observed in deciduous teeth in the age group of 4-yr-old children—4.2 pCi ^{90}Sr/g Ca and in permanent teeth in 10-yr-old children—1.6 pCi ^{90}Sr/g Ca. The ^{90}Sr levels in teeth were compared with the findings of other authors. The results were analyzed also for dependence on the quantity of ^{90}Sr in the radioactive fallout. (auth)

46606 CHEMICAL RESIDUES IN MILK. SECTION VI. RADIOACTIVE CONTAMINATION. Mocquot, G.; Ducluzeau, R. Annu. Bull., Int. Dairy Fed.; Part 5, 85-131(1968).

A comprehensive discussion of the radioactive contamination of milk is presented. The natural and artificial sources of radionuclides are defined, the transport of these nuclides through the food chain (fallout-fodder-cattle-milk-man) is described, and the incidence of ^{90}Sr, ^{131}I, and ^{137}Cs in milk at various locations is given. The repercussions on public health of radioactive milk contaminants are discussed in terms of the biological, physical, and genetic effects of radiation and the factors such as biological and physical half-life and ability to pass through the food chain that affect or modify the hazards of the presence of particular radioisotopes in milk. The existing analytical methods for detecting the presence of specific radionuclides in milk are examined and the problems inherent in sampling techniques that affect the analyses are stated. The effects of processing, manufacturing, and storing milk and milk products on the level of radioactive contamination are examined and the prevention of contamination at the production and processing level and at the consumer level is considered. The protection of the consumer is discussed in terms of the activities of responsible authorities, the means employed by these authorities, and the setting of standards (maximum permissible levels) for radioactivity in milk. (E.R.B.)

Dosimetry and Monitoring

Refer also to abstracts 46362, 46480, 46487, 46515, 46516, 46535, 46585, 46644, and 47527.

46607 (ANL-7680) THE ARGONNE RADIUM STUDIES: COMPUTED RADIOBIOLOGICAL INDICES. Miller, Charles E.; Finkel, Asher J. (Argonne National Lab., Ill.); Hasterlik, Robert J. (Argonne Cancer Research Hospital, Chicago, Ill.). Apr 1969. Contract W-31-109-eng-38. 110p. Dep. CFSTI.

Data are tabulated on a number of radiobiological indices for 208 humans with a ^{226}Ra burden acquired by ingestion during occupational exposure. Data are included on the exposure history of each person, radium body burdens as determined by whole-body counting, radiographic changes in bones attributed to radium, daily dose rate to the skeleton of each patient calculated in rads, and calculations of the radiation dose for a hypothetical patient who worked 30 days and contained 1 μCi of Ra on the 14,000th day following cessation of employment. Computer programs were used to compile the data. (C.H.)

46608 (JAERI-4047) MICRODOSIMETRY: THE NEW CONCEPT OF THE DOSIMETRY. Numakunai, T.; Ohtani, S.; Kawai, K. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment). Aug 1968. 39p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

In 1962, the International Commission on Radiological Units and Measurements (ICRU) recommended, for protection purposes, the new concept of the dose equivalent, DE, which is defined as the product of absorbed dose, D, quality factor, QF, distribution factor, DF, and other necessary modifying factors. However, there has recently been much discussion of the fundamental concepts and qualities employed not only in radiation dosimetry but also in radiation biology, chemistry, and many other fields. In this connection, some problems about D and QF are discussed here. From these discussions it has become apparent that the concept of LET distribution of dose has some limitations. Instead of these, new concepts of microdosimetry, microscopic distribution of energy transfer, and of density in irradiated medium and correlations between this information and final effects are proposed. In this paper, two theories of microdosimetry, which were proposed by H. H. Rossi and N. Oda, are introduced and some characteristics that must be included in the primary energy transfer are also discussed. (auth)

46609 (LIB/Trans-277) USE OF CHROMOSOMAL ANALYSIS AS A BIOLOGICAL DOSIMETER. Biola, M. T.; Le Go, R. Translated by A. Morgan (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from pp 33-45 of Proceedings of the First International Congress of Radiation Protection, Vol. I, 1966. 27p. Dep. CFSTI (U. S. Sales Only).

An abstract of this article, prepared from the original, appeared as NSA 23: 12055. (Australia)

46610 LIQUID SCINTILLATION TRITIUM DOSIMETRY IN AQUEOUS SAMPLES USING A SIMPLE ELECTRONIC EQUIPMENT. Chorvat, Dusan; Fojtik, Marian. Prac. Lek.; 22: 54-7(Mar 1970). (In Czech).

A simple equipment using the liquid scintillator of SLS 31 type was used for the determination of tritium in water and human urine samples. The detection efficiency of 0.001 was achieved at the activity level of 10^{-6} Ci of tritium in sample. Maximum possible content of water in a measured sample was 10%, or 3% for urine respectively. It is possible to increase the efficiency by means of the appropriate choice of the measuring cell shape by the optimal optical connection of cell with the photomultiplier. (auth)

46611 CHEMICAL PARAMETERS FOR MEDICAL EVALUATION OF WATER. d'Almeida, Amaro (Instituto Superior Tecnico, Lisbon). Rev. Port. Quim. (Lisbon); 11: Nos. 1-4, 98-104(1969). (In Portuguese).

The important parameters for the medical classification of waters are described: temperature, residue, subsidiary mineralization, radioactivity, HS— ion concentration, and pH. Methods for classification and interpretation based on these parameters are presented. (auth)

46612 DOSIMETRY IN THE EMPLOYMENT OF PROTECTIVE GRILLES. Granone, F. G.; Granone, G. (Univ., Turin). Minerva Radiol.; 15: 36-7(Jan-Feb 1970). (In Italian).

A personal method and formulae employed for the determination of radiation dose values under protective grilles are presented. (auth)

46613 PRELIMINARY ESTIMATE OF THE HAZARD FROM INGESTION OF TRITIATED THYMIDINE. Wade, Leo Jr.; Shaw, Edward I. (Univ. of Kansas, Lawrence). Radiat. Res.; 43: 403-15(Aug 1970).

The data presented led to the following conclusions: there is significant incorporation of tritiated thymidine into all tissues of the mouse after oral ingestion; at least part of this incorporation is not related to mitotic activity; intraperitoneal injection produces greater nonvolatile tissue activities in proliferative tissues than oral ingestion; a radiation effect is produced by levels of tritium activity that deliver a radiation dose to the nucleus that is not greater than 15 rads; and assuming that metabolism is comparable to that in the mouse, a single oral ingestion of 1.0 mCi or less of tritiated thymidine by man would be required to deliver a radiation dose of 1.25 rads over a period of 13 weeks to the nuclei of a significant fraction of cells in the total body. (auth)

46614 EXTERNAL RADIATION DOSES DEPOSITED IN THE REGION OF SACAVEM DURING THE PERIOD OF OCTOBER 1964 AND MARCH OF 1968. da Fonseca, Augusto Jorge Ribeiro (Lab. of Nuclear Physics and Engineering, Sacavem, Portugal). Rev. Port. Quim. (Lisbon); 11: Nos. 1-4, 133-41(1969). (In Portuguese)

The external radiation doses due to recent fission products deposited in the Sacavém (Portugal) region between October 1964 and March 1968 were calculated using a modified version of the method described by Halden and Harley for a uniform surface distribution of the same products. A short discussion follows concerning the precision and limitations of this method. (auth)

46615 THERMODYNAMIC FORMULATION OF RADIATION DOSE RATE. Johnson, Horton A.; Pavelec, Mildred (Brook-

haven National Lab., Upton, N. Y.). Radiat. Res.; 43: 504-13 (Sep 1970).

The relationship between dose of ionizing radiation and any of its biological effects is entirely empirical. Since radiation effects are the results of the addition of free energy to a living system, it would seem that dose–effect relationships could be expressed in thermodynamic terms. This can be accomplished to a first approximation by adding all of the absorbed radiation energy to the free energy pool of the irradiated system. The effect of this increase in Gibbs free energy on chemical reaction kinetics can then be calculated according to the theory of absolute reaction rates. This approximation was tested in a simple chemical system, the radiation inactivation of dry horseradish peroxidase. Theoretical predictions of the dose–effect relationship were in close agreement with experimental results. This indicates that most of the absorbed radiation energy, in the process of being degraded to heat, becomes available to activate the chemical reaction. (auth)

Radiation Protection

Refer also to abstract 46678.

46616 RADIATION HYGIENE AND ITS PRACTICE IN DENTISTRY AS RELATED TO FILM VIEWING PROCEDURES AND RADIOGRAPHIC INTERPRETATION. Wuehrmann, Arthur H. (Univ. of Alabama, Birmingham). J. Amer. Dent. Ass.; 80: 346-56(Feb 1970).

Diagnostic yield is recognized as an important factor in radiation hygiene and radiation protection. Although the exposure of the human body to x radiation is biologically undesirable, the exposure can be totally justified provided the x radiation is used in an efficient, judicious, and productive manner. The diagnostic yield from one technique compared to another can be quite different. Each dentist should view films in a systematic fashion and be certain that his interpretive competency is beyond question. (auth)

46617 RADIATION INJURY IN SURGEONS. Sirotko, A. I. Khirurgiya (Moscow); 45: 117(Feb 1969). (In Russian).

Effects of radiation on medical personnel exposed to it have been attributed to the increased sensitivity of the hands toward disinfectants used for scrubbing. There is a case on record which involved a surgeon whose problem was misdiagnosed as eczema of the fingers and was treated with x radiation to cure him. The further aggravation of the situation made it necessary to amputate his index finger. Examination of a group of surgeons complaining of cysts on the hands revealed that radiation injury has been responsible for the cysts in 15 to 20% of the cases. In two exceptionally serious cases severe radiation injury was noted after a single exposure of the hands. The recently introduced technique of angiography, pneumoencephalography and pneumomyography requires high-power x-ray machines which are often insufficiently shielded; in addition, the physicians often do not receive proper training in radiation protection. This situation should be brought to the attention of all physicians, especially that of surgeons. Only specially trained personnel should be given access to these potentially dangerous devices. (TTT)

46618 BASIC APPROACH FOR SAFETY ANALYSIS AND CONTROL OF PRODUCTS CONTAINING RADIONUCLIDES AND AVAILABLE TO THE GENERAL PUBLIC. Paris; European Nuclear Energy Agency (1970). 32p. $1.50.

A group of experts of international origin has, under the sponsorship of the European Nuclear Energy Agency (ENEA), established a guide for the safety analysis and control of consumer products containing radioisotopes. The guide deals with both general considerations and control procedures. The general considerations involve determination of the external radiation dose or dose commitment from a single product or multiple products to an individual member of the public or the population in general. The control procedures include surveillance, testing, notification or instruction, and identification of product. An appendix presents a dose apportionment for products exempted from the guidelines on the basis of risk/benefit considerations. Two annexes are included that present radiation protection standards for classes of exempt products and the present status of products containing radioisotopes and are available to the general public. (E.R.B.)

Safety Procedures

Refer also to abstracts 46575 and 46597.

46619 RADIATION EFFECTS ON THE EYE. Geeraets, Walter J. Sight-Sav. Rev.; 39: 181-96(Winter 1969).

Five segments of the electromagnetic spectrum were chosen for discussion because of their wide use by industry, research, clinical medicine, the military, and the general public. These five spectral segments include: ionizing radiation (γ rays and x rays); uv radiation; the visible spectrum including near infrared radiation; far infrared radiation; and microwaves and radio frequencies. Following a brief discussion of eye-protection and hazard-control programs, the background, uses in medicine, potential biological hazards (especially to the eye), and radiation levels considered harmless for each of these radiations are discussed. (E.R.B.)

Legal Aspects

Refer also to abstract 46681.

46620 (AEET/HP/Th-15(Rev.)) MAXIMUM PERMISSIBLE CONCENTRATIONS OF FISSION PRODUCT MIXTURES IN AIR AND WATER FOR OCCUPATIONAL EXPOSURE. Iyer, M. Ramakrishna; Krishnamurthi, T. N. (Atomic Energy Establishment, Trombay (India). Health Physics Div.). 1966. 40p. Dep. CFSTI (U. S. Sales Only).

Maximum Permissible Concentrations of uranium-235 fission product mixtures in air and water for a 40-hour-week occupational exposure were calculated for irradiation times of 10^6, 10^7, and 10^8 seconds and decay times from 10^3 seconds to 10^8 seconds. In the calculations the thermal neutron flux was taken as 10^{13} n/cm^2/sec. All the fission products (83) for which Maximum Permissible Concentrations are listed by ICRP were taken into account in the computations. MPC's were calculated for 21 organs out of which the results for the nine most radiosensitive organs are presented. The lowest value of MPC for any of the organs in air and water are plotted as a function of cooling time for the three irradiation times. MPC of the fission product mixture varies from 1.8×10^{-7} μCi/cc to 5.0×10^{-9} μCi/cc in air and from 1.2×10^{-3} μCi/cc to 5.5×10^{-5} μCi/cc in water during the course of the irradiation and decay history considered. The critical organs for the fission product mixture for the different cases are presented. (auth)

46621 (NP-18343) ILLINOIS ENVIRONMENTAL PROTECTION ACT, 1970. 1970. 35p.

The text of the 13 titles of this act to protect the environment and to repeal certain other acts of the State of Illinois is presented. The organization of the Pollution Control Board and its authorities are given. The scope includes air, water, land, and noise. Authorization of standards for water quality and for effluents is given. Title VI-A covers atomic radiation. It provides that nuclear generators or fuel reprocessing plants must file an environmental feasibility report. Also provided for is a public hearing on environmental effects. Permits must specify the maximum level of radioactive discharge and there is a requirement for monitoring such discharge. (C.O.)

Medicine

Refer also to abstract 46434.

Protective Substances

Refer also to abstracts 46579 and 46687.

46622 CHEMICAL STATE AND CONTENT OF RADIOPROTECTOR IN SOME TISSUES OF RAT AT EARLY TIME-INTERVALS AFTER CYSTAMINE ADMINISTRATION. Koshcheenko, N. N.; Filippovich, I. V.; Romantsev, E. F. (Inst. of Biophysics, Moscow). Vop. Med. Khim.; 16: 69-72(Jan-Feb 1970). (In Russian).

The relative content of MEA, cystamine, and mixed disulphides of protector with cellular proteins in rat thymus, spleen, and liver during 3 hr after i. p. cystamine administration at a radioprotective dose was studied. It was established that at all time-intervals studied, only mercapto forms of the protector were found in tissues. Cystamine and mixed disulphides content was less than 0.01 μmole per 25 to 100 mg of tissue. The coincidence of maximal radioprotective effect and MEA accumulation in the tissues studied after cystamine administration was noted. One, and the same, biochemical mechanism (or mechanisms) of radioprotective action for MEA and cystamine may be postulated on the base of similarity between time-course of MEA accumulation in various tissues after MEA and cystamine administration. The difference between these results and those from paper of Betz (Betz E. H., Mewissen D. J., Lelievre P., Intern. J. Rad. Biol., 1962, 4, 231) probably may be explained by the fact that in the paper of Betz the tissues were not washed before homogenization. (auth)

Radiation Sickness and Injuries

46623 TREATMENT OF LOCAL AND GENERALIZED RADIATION SIDE-EFFECTS. Kaercher, K. H. Langenbecks Arch. Chir.; 325: 993-7(1969). (In German).

With the use of high-intensity radiation, side-effects and delayed damage to skin, mucous membrane, and bone have become less serious and rarer. Nowadays mainly accidental radiation damage is seen, and conservative measures produce only limited success, dependent on the type of radiation, the dose, and period of application. With the correct use of certain local, mainly bland remedies, supported per os or parenterally by vasoactive drugs like HR, mucous membrane reactions play a minor part and as a rule do not require an interruption of radiotherapeutic measures. General reactions, too, have become so slight in frequency and degree with modern types and methods of radiation that they can be easily controlled and do not force us any more to discontinue radiotherapeutic measures. Most important here is the space dose and the irradiated body region. The use of electrolyte infusions, vitamin B_6, HR, and Trasylol in combination with anabolic hormones as planned polypragmasy allows a successful conclusion of radiotherapeutic measures and mostly leads to a remission of the tumor and satisfactory improvement of the patient. Side-effects due to radiotherapy have diminished with technical advances and biological discoveries and constitute no longer a serious therapeutic problem. (auth)

Radiodiagnosis

Refer also to abstracts 46482, 46563, 46616, 46674, and 46677.

46624 (TT-69-50002/4) POLISH REVIEW OF RADIOLOGY AND NUCLEAR MEDICINE. Translated reprint of Pol. Przegl. Radiol. Med. Nukl.; 33: No. 4, 307-468(1969). 101p. CFSTI.

Separate abstracts were prepared for three of the 23 translations appearing in this review. The other papers discuss routine methods of radiodiagnosis and radiotherapy, and other techniques in radiology and nuclear medicine. (E.R.B.)

For abstracts of individual papers see: 46625, 46626, and 46640.

46625 (TT-69-50002/4, pp 418-25) PECULIARITIES OF THE ROENTGEN TECHNIQUE OF ANGIOGRAPHY IN CHILDREN. Wermenski, Kamil. Translated from Radiol. Med. Nukl.; 33: No. 4, 1969.

Roentgen diagnosis of the blood vessels is a method coming into increasing use in childhood diseases. Differences of the technique of the examination in infants and young children are discussed in this article. (auth)

46626 (TT-69-50002/4, pp 443-6) ROLE OF SUBTRACTION IN ANGIOGRAPHY. Januszkiewicz, Stanislaw; Naturska-Targosz, Halina. Translated from Pol. Przegl. Radiol. Med. Nukl.; 33: No. 4, 1969.

The simplest subtraction technique for seriographic radiograms which, without requiring complicated or expensive apparatus, would give satisfactory results for the needs of diagnosis and especially teaching was determined. Best results were attained by making roentgenograms of the background (ballast) separately with an additional element (e.g., angiogram) on glass photographic plates (9 × 12 cm) and making diapositives of one of them (i.e., negative duplicates) by the contrast method. Subtraction prints were made photographically from the negative and positive plates placed with the emulsions facing each other. This method gave all three elements serving subtraction and similar photographic material, and was less laborious and expensive. (E.R.B.)

46627 CONGENITAL INGUINAL HERNIA AND INGUINAL HERNIOGRAPHY. White, John J.; Haller, J. Alex Jr.; Dorst, John P. (Johns Hopkins Univ., Baltimore). Surg. Clin. N. Amer.; 50: 823-37(Aug 1970).

Ease of performance, mild discomfort to the child, low radiation dose, and high degree of accuracy suggest that inguinal herniography should be seriously considered in all children in whom a hernia is suspected but not confirmed by physical examination, and in all children presenting with a hernia on one side only. Hernia repair can then be performed as indicated by inguinal herniography, rather than doing a blind exploration on all of these patients, or withholding surgery because of the negative physical examination. (auth)

46628 POSSIBLE ROLE OF HOSPITAL RADIOLOGY DEPARTMENTS IN CROSS INFECTION AND ANTIBIOTIC-RESISTANT BACTERIAL MUTAGENESIS. Haskin, Marvin E.; Bondi, Amedeo; Holmes, Robert H.; Wolferth, Charles C. Jr.; Heineman, Herbert S.; Schloss, John J.; Fields, Peter A.; McGinley, John A. (Hahnemann Medical Coll. and Hospital, Philadelphia). Surg. Clin. N. Amer.; 50: 945-52(Aug 1970).

Based on the best documented information concerning the incidence of postoperative wound infection and the mortality rate of those infected, an investigation was initiated into the potential role of the hospital radiology department in cross infection and antibiotic-resistant bacterial mutagenesis. In the study, not only were a number of pathogenic microorganisms isolated from fomites in diagnostic x-ray rooms and portable x-ray machine cassettes, but it was also determined that the x-ray dose used in diagnostic procedures was within the mutagenic range for these microorganisms. Viral contamination of fomites might also be implicated in bacterial-virus mediated mutation of bacteria to antibiotic resistance. (E.R.B.)

46629 DETERMINATION OF BLOOD FLOW IN MUSCLES USING RADIOACTIVE ZENON (^{133}Xe) IN CASES OF PROGRESSIVE MUSCULAR DYSTROPHY. Kapuscinska, B.; Kapuscinski, A.; Stroinska, B. (Dept. of Neurology and Lab. of Radioisotopes, Warsaw). Pol. Med. J.; 9: 506-11(1970).

The method for determination of blood flow in muscles—quadriceps femoris and anterior tibialis at rest—using ^{133}Xe was demonstrated in a group of 10 healthy subjects and 17 patients with progressive muscular dystrophy. The mean values of blood flow were lower in these patients as compared to the controls. The value of the method and sources of its errors are discussed. (auth)

46630 EXAMINATION WITH TWO RADIOTRACERS IN THE DIFFERENTIAL DIAGNOSIS OF LIVER PARENCHYMAL DAMAGE. Toth, Z.; Forgalski, W. (Center of Radiological Protection and Radiobiology, Warsaw). Pol. Med. J.; 9: 338-41(1970).

In a group of 50 subjects, blood-clearance studies of ^{131}I-rose bengal and colloidal ^{198}Au were carried out. To take into account the effect of the condition of the hepatic blood flow on the test with ^{131}I-rose bengal, a coefficient was introduced amounting to the ratio of the clearance half-time of labeled rose bengal to that of colloidal ^{198}Au. A positive opinion is expressed with regard to the value of the proposed coefficient in the differential diagnosis of liver cirrhosis versus other liver parenchymal diseases. (auth)

46631 ^{75}Se SELENOMETHIONINE ISOTOPE LYMPHOGRAPHY IN LYMPHOMA: CORRELATION WITH LYMPHANGIOGRAPHY. Ferrucci, Joseph T. Jr.; Berke, Raymond A.; Potsaid, Majic S. (Harvard Univ., Boston, Massachusetts General Hospital, Boston). Amer. J. Roentgenol., Radium Ther. Nucl. Med.; 109: 793-802(Aug 1970).

Concentration of intravenously administered ^{75}Se-selenomethionine in lymphoma tissue permits scintigraphy of these neoplasms. The diagnostic accuracy of the simple and well-tolerated isotope lymphogram was evaluated in a series of 33 lymphoma patients whose disease was staged by roentgen lymphangiography. The technique for scintigraphy was refined, and normal and abnormal patterns of ^{75}Se distribution were determined using the roentgen lymphangiogram as a standard. The comparison showed that a negative isotope study did not reliably exclude disease, whereas an abnormal scintigram indicated a 70 to 80% likelihood that disease was present. Certain patterns of ^{75}Se distribution were reliable evidence of pathology; other patterns, much less so. In some instances an abnormal isotope lymphogram would be a reasonable alternative to the conventional lymphangiogram for staging purposes. (auth)

46632 NOTES ON POSITIVE SCINTISCAN FINDINGS IN PAGET'S DISEASE. Scopinaro, G.; Damiani, S.; Sanguineti, M. (Galliera Hospital, Genoa). Minerva Radiol.; 15: 1-4(Jan-Feb 1970). (In Italian).

Positive scans may be observed in Paget's disease without offering any evidence that assists in the formation of a diagnosis. In some cases a greater or lesser scintiscan positivity was noted with respect to the radiological picture. The possible interpretations of findings of this kind are discussed. (auth)

46633 USE OF RADIOIODINE-LABELLED TRIOMBRIN FOR DETERMINATION OF THE GLOMERULAR FILTRATION. Sysoev, V. F.; Kozlova, V. N. (Inst. of Rheumatism, Moscow). Med. Radiol.; 15: No. 1, 39-43(Jan 1970). (In Russian).

A technique is described for determining glomerular filtration based on a single injection and evaluation of the mean concentration of radioiodine-labeled thriombrine during the period of clearance on the basis of a single blood test and continuous recording of changes in the concentration of radioiodine-labeled thriombrine on the precardial curve. (auth)

46634 RADIOISOTOPES IN THYROIDITIS' DIAGNOSIS. Austoni, M.; Busnardo, B. (Univ., Padua). Acta Isotop.; 9: 325-36(30 Sep 1969). (In Italian).

The semeiologic accuracy of some radioisotopic, biochemical, and immunologic tests in 60 cases of thyroiditis was reviewed

with the purpose of evaluating their diagnostic significance. The study was done on 29 cases of Hashimoto's thyroiditis, 22 cases of De Quervain's or subacute thyroiditis, 3 cases of Riedel's thyroiditis, and 6 histologically unclassifiable cases. The results of the present study indicate that, while there are not single signs and tests with pathognomonic value, their association in symptom complexes can be of diagnostic significance, especially in the differential diagnosis. (auth)

46635 CLINICAL NUCLEAR MEDICINE. Maynard, C. Douglas. Philadelphia; Lea and Febiger (1969). 290p. $12.50.

A clear and concise introduction to nuclear medicine is presented for use by medical students and practicing physicians who are unaware of the numerous valuable radioisotope procedures now available for use in diagnosis. The principles involved, the procedures, methods for patient preparation, and the value and limitations of commonly used diagnostic radioisotope studies are discussed. The uses of radioiodine in the treatment of thyroid diseases and radiocolloids in the treatment of malignant diseases are described. Data on the radiation exposure of patients associated with each diagnostic test are included. Radioisotope scanners and typical radioisotope scans are illustrated. (347 references) (C.H.)

46636 EARLY ALTERATIONS OF THE IRRADIATED LUNG: EVALUATION OF SCANS. Giannardi, G.; De Marzi, S.; Masi, R.; Cappelli, G. (Univ., Florence). Acta Isotop.; 9: 403-7 (30 Sep 1970).

Lung scanning by means of ^{131}I–MAA carried out in 18 patients irradiated after mastectomy in the apical region showed, at an early stage, hypoirroration of the irradiated lung when x-ray examination was negative. These alterations, appearing to be transitory, may well be an indication of a treatment-induced vasal damage, initially reversible. (auth)

46637 PRELIMINARY REPORT ON THE APPLICATION OF NEW ^{68}Ga-LABELED COMPOUNDS FOR SECTION SCANNING. Colombetti, L. G. (Stanford Univ., Calif.); Ravasini, R. Acta Isotop.; 9: 375-90(30 Sep 1969). (In Italian).

A review of the literature as well as of the radiochemical textbooks indicates that ^{68}Ga is one of the best available isotopes among positron-emitting isotopes. It was found to be an easy and speedy procedure to form ^{68}Ga compounds, avoiding the slow and inconvenient phases of sterilization. It was proved available for selective localization in the organs both as macroaggregates and as colloids. The tomographic tests scanned by gamma-camera confirmed in this early phase the good characteristics of compound distribution. Further studies will be carried out to obtain better characteristics of resolution. Low toxicity of the compounds in animals and possible applications in man are demonstrated in these experiences. (auth)

46638 INHALATION LUNG SCANNING BY COLLOIDAL ^{198}Au AEROSOL. Blandino, G.; Bonanno, N.; Capone, M.; Salvi, L. (Univ., Messina, Italy). Acta Isotop.; 9: 357-73 (30 Sep 1969). (In Italian).

The mechanisms, actually known, of deposition and clearance of inhaled dust particles in different portions of the respiratory tract are summarized, and the best technical methods for obtaining a good lung scan following the inhalation of nebulized colloidal ^{198}Au are pointed out. Based on the data obtained from these studies, the most suitable time of scanning was estimated at around the 16th hr after inhalation. The possibilities and limits of this new scanning technique are evaluated. (auth)

46639 MEDICAL RADIOLOGY AND PROGRESS IN PHYSICS AND TECHNOLOGY. Zdansky, E. Schweiz. Med. Wochensch.; 100: 249-57(7 Feb 1970). (In German).

Applications in the medical field were not primary concerns of radiation physics and technology, and it is thanks to the initiative of interested physicians that ionizing radiation became a tool of diagnostic and therapeutic medicine. Valuable suggestions for the construction of equipment for X-ray diagnosis, treatment and dosimetry came from the medical profession, and this brought rapid progress in radiophysical technology and chemico-pharmaceutical research. The rapid progress of physics and technology on the one hand, and the unceasing efforts of medical researchers towards new achievements in x-ray diagnosis and treatment on the other, have imposed increasing responsibility on medical radiology. The radiologist must always consider three questions: Is the radiation exposure involved in new diagnostic or therapeutic methods justified from the patient's standpoint? Does it involve any other risk for the patient, and if so is the risk justified by the expected medical effect? Does a new technique provide more exact information or a better therapeutic effect than existing radiologic or nonradiologic techniques? (auth)

Radiotherapy

Refer also to abstracts 46612, 46617, 46624, and 46675.

46640 (TT-69-50002/4, pp 429-34) CEREBELLAR MEDULLOBLASTOMA IN CHILDREN WITH METASTASES TO THE SKELETAL SYSTEM. Borowska-Lehman, Jolanta; Jungowska, Anna; Kamraj-Mazurkiewicz, Krystyna; Dilling-Ostrowska, Ewa; Drewniak, Kazimiera. Translated from Pol. Przegl. Radiol. Med. Nukl.; 33: No. 4, 1969.

After a brief survey of the literature showing the rarity of metastases of cerebellar medulloblastoma beyond the central nervous system in children, the routes of dissemination of metastases and the importance of early roentgentherapy with high doses of x rays are discussed. (auth)

46641 FIXED FIELD RADIOTHERAPY OF CENTRAL NERVOUS SYSTEM TUMORS USING ^{137}Cs. Vaghi, M. A.; Pesce, S.; Ciancia, C. (Istituto Neurologico, Milan). Radiobiol. Radioter. Fis. Med.; 24: 177-204(May-Jun 1969). (In Italian).

Some standard treatment plans realized for ^{137}Cs in fixed field radiotherapy of the central nervous system tumors are presented. These plans comply with the requirements of the almost totality of the tumors to be treated in a Neuro-Radiology Department and they are very simple and easy to make. (auth)

46642 RADIOTHERAPY OF PRIMARY VAGINAL CARCINOMA. Rimondi, C.; Pezzi, A. (Univ., Bologna). Radiobiol. Radioter. Fis. Med.; 24: 205-23(May-Jun 1969). (In Italian).

The results of radiation treatment on 72 patients with primary vaginal carcinoma, treated at Istituto di Radiologia e del Radio "L. Galvani," Bologna University, during the period from 1932 up to 1963 are presented. The possibilities of radiotherapy differ according to the various stages of the illness, being good or moderate in circumscribed forms and very limited in advanced stages. The necessity is pointed out of an early diagnosis, when possible in preclinical phase; of a detailed radioclinical study for each case allowing a suitable anatomo-evolutive picture; of an endocavitary and transcutaneous radiotherapy accurate in program and execution, in order to obtain better results and a reduction in post-irradiatory complications. (auth)

46643 INVESTIGATION INTO THE PHYSICAL BASES OF GRID PROJECTION WITH LARGE GAMMA SOURCES. Bozoky, L.; Rode, I. (National Inst. for Oncology, Budapest). Acta Phys. Acad. Sci. Hung.; 28: 83-6(1970).

The possible extension to γ rays of the projected grid irradiation method developed for x-ray therapy is examined. On the basis of dose distribution measurements performed in a MIX-D phantom the characteristics of a projected grid are defined, relations between the size of grid openings, their spacing, the size of the radiation source, and the hardness of radiation, as well as a criterion to assess the quality of the grid are developed. A projection grid designed on the basis of the investigations, suitable for total irradiations, is described. (auth)

46644 PRODUCTION OF SOLID ^{60}Co RADIATION SOURCE ETALONS WITH AN ACTIVITY OF 1 TO 100 mCi. Erbeszkorn, L.; Szokolyi, L.; Szoerenyi, A.; Zsdanszky, K. (Staatliches Amt fuer Messwesen, Budapest). Isotopenpraxis; 6: 80-4(Mar 1970). (In German).

Solid ^{60}Co radiation source etalons with an activity of 1 to 100 mCi were made. The value of activity was determined by the simultaneous application of the absolute and relative measuring methods. Several radioactive sources with nearly the same activity and size were made by activation of cobalt wire. The ratios of the activity of these sources were determined with high accuracy by means of an ionization chamber. Then a few wires were dissolved and the specific activity of the solution was measured with the 4π β–γ-coincidence method. The activity values of the radiation sources were calculated from the results of the absolute activity measurements and the ratios of the ionization currents. The statistical error (2σ) of the individual radiation source etalons is less than ±0.05% and their systematical error is less than ±0.4%. The measuring uncertainty is less by at least one order of magnitude than the uncertainty encountered with the calorimetric method or with an ionization chamber, for absolute measurements of the radioactivity of preparations. (auth)

46645 EXTRACORPOREAL IRRADIATION OF THE BLOOD. I. TREATMENT OF CHRONIC LYMPHOCYTIC LEUKAEMIA. Andersen, Vagn; Weeke, Eva; Soerensen, Soeren Freiesleben; Killmann, Sven-Aage. Ugeskr. Laeger; 132: 575-80(19 Mar 1970). (In Danish).

Extracorporeal irradiation of the blood (ECI) was employed in the treatment of 13 patients with chronic lymphocytic leukemia whose general condition and bone marrow function were affected

by the disease. The average transit dose was 515 rads; average total dose was 48,300 rads. In all patients, the lymphocyte concentration in the blood fell to 10,000/μl or less, and in all except one of the patients the lymphoid tissues decreased in size. Bone marrow function improved in six patients, but became normal in one only. In those cases in which no other treatment was given, these parameters reached pre-ECI levels within 7 to 13 months on the average. It is concluded that ECI offers little to patients with severely impaired bone marrow function. In the early stages of chronic lymphocytic leukemia, ECI may be of benefit and allow postponement of conventional therapy with its attendant risks. (auth)

46646 THE PHYSICS OF RADIOLOGY. THIRD EDITION. Johns, Harold Elford; Cunningham, John Robert. American Lecture Series, Publication Number 743. A Monograph in the Bannerstone Division of American Lectures in Radiation Therapy. Springfield, Ill.; Charles C Thomas, Publisher (1969). 810p. $24.75.

The following topics are discussed in the third edition of this textbook. The structure of matter and radiation, the production and properties of x rays, the fundamentals of nuclear physics, high energy and teletherapy machines, the absorption of radiation, the measurement of radiation, the quality of x rays, the measurement of absorbed dose, the interaction of x- and γ rays with a scattering medium, the combination of radiation fields for clinical use, rotation therapy, energy absorption in biological material, radium and radium dosage, clinical uses of isotopes, diagnostic radiology, radiation protection, and radiobiology. The appendix contains tables of data of interest to radiation physicists and radiologists including: tissue-air ratios; backscattering factors; compilations of depth-dose data; scatter functions for various radiations; and scatter-air ratios for low-energy radiations. Subject and author indexes are also included. (E.R.B.)

46647 EXTRACORPOREAL IRRADIATION OF THE BLOOD. II. IMMUNOSUPPRESSIVE TREATMENT IN KIDNEY TRANSPLANTATION. Weeke, Eva; Andersen, Vagn; Soerensen, Soeren Freiesleben; Bahr, Bjarne. Ugeskr. Laeger; 132: 580-5 (19 Mar 1970). (In Danish).

Seventeen consecutive patients in terminal uraemia were treated with extracorporeal irradiation of the blood (ECI) as pre-transplantation immuno-suppressive therapy. Eleven patients have received a kidney transplant, and eight of these were treated with ECI after the transplantation also. The transit dose employed was 280 to 610 rads; the average total dose 54,600 rads. In all patients, the lymphocyte concentration in the blood decreased during ECI, on the average to 20% of pretreatment values, or 290 ± 110/μl. No correlation was observed between transit dose and decrease in lymphocyte concentration. After ECI the lymphocyte counts have remained below 50% of pretreatment values in all patients including those who were not transplanted and therefore did not receive other immunosuppressive therapy (maximum 14 months of observation). Ten patients received a kidney transplant from a related living donor (2 A 1 match, 6 C match, 2 D match) and one a necrokidney (D or E match). All transplanted patients were treated with azathioprine and prednisone; the dosages employed were relatively small. Two rejection episodes have occurred, both slight and reversible, and renal function is now, 1 to 12 months after transplantation, normal in all. Further clinical and experimental studies are necessary in order to clarify the role of ECI as immunosuppressive therapy. (auth)

Radiation Effects on Animals

46648 INTRACLONAL RECOVERY OF DIVISION PROBABILITY IN PEDIGREES OF SINGLE X-IRRADIATED MAMMALIAN CELLS. Trott, K. R.; Hug, O. (Univ., Munich). Int. J. Radiat. Biol.; 17: 483-6(1970).

Data are presented on the dependence of division probability on the number of post irradiation generations. L-cells with a mean generation time of 24 hrs were grown in Sykes-Moore chambers on microscope stages under controlled temperature and pH conditions. Irradiation was performed with 45 kV x-rays at a dose-rate of 200 R/min, and microcinematographic recording was carried on for 6 to 10 days, the cells being classified according to time elapsed since their formation at the last pre-irradiation mitosis. The division probability of unirradiated cells was 0.96 in all generations. In progeny of cells irradiated in G1-phase, the division probability dropped in the following two generations and then recovered, the depth of the curve trough depending on radiation dose. After 400 R, the depression was too large to allow many cells to reach the 4th generation. The inactivation rate depended also on the cell-cycle phase at the time of irradiation, being most depressed in cells irradiated later than 21 hrs after mitosis, less in the 12 to 20 hr group, and least in the 0 to 4 and 5 to 12 hr groups. In all groups the probability rose again in the 3rd and 4th generations. In the 6th post irradiation generation, (200 R), the division probability was still reduced compared with pre-irradiation values. No evidence was found supporting the "lethal-sectoring" theory. (UK)

Invertebrates

46649 EFFECT OF X-IRRADIATION ON THE REGENERATION OF THE PLANARIAN, DUGESIA JAPONICA. Asakura, Koshu; Kishida, Yoshikazu; Kido, Tetsuji (Kanazawa Univ., Japan). Sci. Rep. Kanazawa Univ., 14: 253-61(Dec 1969).

When Dugesia japonica was irradiated with 5000 R of x ray, all exposed worms died on the 12th day after irradiation. Regeneration of the worms dissected at 48 hr after irradiation at 5000 R was completely inhibited, and the shorter the interval between irradiation and dissection, the more the regeneration rates increased. When irradiated with 5000 R, dissection at intervals of 24 hr or greater after irradiation resulted in regeneration rates of 100%, but the regenerates ultimately died. At intervals less than 24 hrs, the regeneration rate was gradually decreased. Redissection of the dissected worms irradiated with 5000 R gave no significant result for regeneration. Histological observation of the worms dissected at 48 hr after 5000 R irradiation revealed that the wound surfaces of the epithelium and intestinal tissue were closed with their own tissues as was the case in non-irradiated dissected worms. At no time after the dissection was accumulation of the basophilic regenerative cells and mitotic figures distinctly recognizable. (auth)

Vertebrates

Refer also to abstracts 46561, 46568, 46569, 46576, 46582–46584, 46590, 46591, and 46613.

46650 (AD–702766) MAMMALIAN RADIOSENSITIVITY. Final Report, May 1968–May 1969. Cromroy, Harvey L. (Florida Univ., Gainesville. Dept. of Entomology and Radiology). Dec 1969. Contract N00228-68-C-2658. 28p. CFSTI.

A critical appraisal is given of the data currently available on LD50/30 for mammals. A reevaluation of data from two previous reports as well as newly obtained data was done. This resulted in a subdivision of mammals for the purposes of predictor slopes into two groupings, rodents and mammals other than rodents. Predictor slopes of the latter, mammals other than rodents, were excellent. The rodents, however, displayed some unusual features. The female rodent species gave a slope that agreed with previous slopes of Sparrow and co-workers on plants indicating the larger the interphase nuclear volume, the more sensitive the mammal was to ionizing radiation. The male of the rodent species gave an opposite type of slope that indicated that the larger the interphase nuclear volume, the less sensitive the animal was to ionizing radiation. The male rodent slope was analogous to the slope obtained for mammals other than rodents. Several interpretations and explanations are given. (auth)

46651 INVESTIGATIONS ON THE EFFECT OF LASER RADIATION ON THE DENTAL PULP IN RABBITS. Jesionowski, M. (Inst. of Postgraduate Medical Education, Warsaw). Pol. Med. J.; 9: 468-74(1970).

The action of laser radiation in a dose of 40 joules on rabbit incisors cause a considerable damage to the dental pulp including even necrosis of the latter. The harmful effect of laser radiation could be observed even on the dental pulp of the teeth adjoining the teeth exposed to radiation. This fact suggests that during procedures involving laser radiation the adjoining teeth should be shielded. The changes observed in the adjoining teeth are probably the initial stages of the action of laser radiation on the tissue. This action involves the walls of the blood vessels changing the content and distribution of neutral polysaccharides in the arterial walls. The lesions of these walls are followed by tissue edema that initiates the process of further tissue lesions. (auth)

46652 MECHANISM OF THE EFFECT OF ULTRAHIGH FREQUENCY ELECTROMAGNETIC FIELD (MICROWAVES). Komarova, L. A. (Leningrad Inst. for Graduate Medical Studies). Vop. Kurortol., Fizioter. Lech. Fiz. Kul't.; 32: 9-13(1967). (In Russian).

Studies of the effects of ultra-high-frequency electromagnetic fields during direct action on the brain in cats showed a strong shift in the neuro-reflectory regulation of autonomic nervous system (blood-circulation, vascular reflexes, respiration, and skin and rectal temperature). The observed reactions during intense doses of uhf electromagnetic field were induced not only by the

thermal factor but also by the effects of the nonheating component of the microwave energy. (R.V.J.)

46653 ATTEMPT AT QUANTITATIVE ANALYSIS OF INTERINDIVIDUAL VARIABILITY IN STRESS RESPONSE OF LEUCOCYTE LEVELS IN MICE FROM THE VIEWPOINT OF CONTROL THEORY. Vacha, Jira; Kacer, Oldrich (Inst. of Biophysics, Brno). Biophysik; 6: 280-9(1970).

The dependence between the ability of systems regulating the level of peripheral leucocytes to damp the fluctuations of this level, occurring under conditions of repeated stressing of the organism by non-specific stress factors (isolation, starvation, handling for blood withdrawal) and the tolerance of the organism to the action of ionizing radiation (summary exposure to x rays leading to death at repeated irradiation) was studied. This regulatory ability was expressed with the aid of the slope (coefficient b) of regression between the leucocytary values x_i, fluctuating in time, and the subsequent differences δ_i ($\delta_i = x_{i+1} - x_i$). The highest tolerance to lethal action of radiation is correlated to such a regulatory behavior of the organism at which the time necessary for adaptation of the system is shortest. The suitability of the employed regulatory characteristic for the quantitative study of adaptability and resistance of the organism and its relatedness to the damping ratio, used in the automatic control theory, are pointed out. (auth)

46654 PRELIMINARY EXPERIMENTS ON THE EFFECT OF ^{60}Co GAMMA RAYS ON EHRLICH ASCITE TUMOUR CELLS OF THE MOUSE IN THE PRESENCE OF FUROCOUMARIN DERIVATIVES. Bordin, Franco; Busulini, Loris; Baccichetti, Francarosa; Bevilacqua, Rita; Musajo, Luigi (Univ., Padua). Ric. Sci.; 39: 558-62(Jul-Sep 1969). (In Italian).

The transmissibility of Ehrlich ascite tumor cells of the mouse was studied in vitro under γ irradiation in the presence of several furocoumarin derivatives among which were some typical skin-photosensitizing furocoumarins very active with long-wave uv light. Of all substances examined, only the 5,8-dihydroxypsoralen, which is biologically inactive with the uv light, has shown sensitizing properties under the action of the γ rays. (auth)

46655 MORPHOLOGICAL AND HISTOCHEMICAL STUDIES DURING CANCERIZATION OF THE INTESTINAL MUCOSA USING 1,2-DIMETHYLHYDRAZINE. Schauer, A.; Voellnagel, Th.; Wildanger, F. (Univ., Munich). Verh. Deut. Ges. Pathol.; 53: 234-6(1969). (In German).

A syncancergenic effect of 1,2-dimethylhydrazine (DMH) and x rays could not be demonstrated. Nearly all benign and malignant tumors observed in man could be found after application of DMH (benign and malignant adenomatous polypous tumors, villous tumors, mixed types of adenocarcinomas and signet ring cell carcinomas, and pure signet ring cell carcinomas). In the fully developed adenomatous tumors of the small intestine, the brush border enzymes (alkaline phosphatase and ATP-ase) were lost. Precancerous enzyme defects could not be found. In adenomatous tumors of the colon, a full or partial loss of nonspecific esterases, sometimes in the same gland, could be demonstrated. Autoradiographic studies of adenomatous and villous tumors showed a band-like high labeling after application of ^{3}H-thymidine at the superficial zone or in small growth centers in the depths of the tumors. (tr-auth)

46656 EFFECTS OF SINGLE-DOSE, WHOLE-BODY, ^{60}Co GAMMA IRRADIATION ON NUMBER OF CELLS IN DNA SYNTHESIS AND MITOSIS IN THE MOUSE DUODENAL EPITHELIUM. Lesher, Janie; Lesher, S. (Allegheny General Hospital, Pittsburgh). Radiat. Res.; 43: 429-38(Aug 1970).

It has previously been established that the intestinal crypt epithelium has a remarkable capability to react to injury by increasing the production of new cells. Accordingly, the seriously injured nonviable and/or dying cells are replaced and the critical steady state necessary for the survival of the animal is reestablished. The number of cells in mitosis (MF/crypt) and in DNA synthesis (LN/crypt) in the mouse duodenal epithelium has been studied at closely spaced time intervals following a series of single-dose, whole-body, ^{60}Co γ irradiation. These studies show that the pattern of change in the numbers of cells in mitosis (M) and synthesis (S) is qualitatively similar at all dose levels. The degree of change is directly related to dose, increasing as dose increases. The results show that: cells are immediately blocked in G_1 and G_2; following an immediate drop in numbers of cells in S and M the number of cells in these two phases rises rapidly and overshoots control values; during the recovery period, the number of S and M cells shows a series of peaks and troughs that are similar to the diurnal fluctuations found in nonirradiated controls; and cell production returns to normal control levels. (auth)

46657 INFLUENCE OF SUBTUMORICIDAL ^{60}Co IRRADIATION ON WOUND HEALING AND TENSILE STRENGTH. Thompson, Lewis W.; Bennett, James E. (Indiana Univ., Indianapolis). Ann. Surg.; 172: 72-5(Jul 1970).

Using two study models in pigs and rabbits, the influence of subtumoricidal ^{60}Co radiation (3000 rads) on wound healing and tensile strength was studied. There was no significant difference in epithelialization of open wounds in radiated versus nonradiated groups but there was a decrease in wound tensile strength in the radiated group 10 days after wounding and a decrease in the total collagen deposition in the wound 12 days after wounding. Tensile strength 6 days after wounding did not appear to be significantly different between the radiated and the nonradiated skin. (auth)

46658 EFFECTS OF IONIZING IRRADIATION ON THE GROWTH OF BONES OF THE PROXIMAL PART OF THE PECTORAL LIMB. Horak, Jindrich; Horakova, Alexandra; Seidelova, Anna. Biologia (Bratislava); 25: 393-401(1970). (In Czech).

The effects of a single exposure of pregnant female rats to 250 R from the 11th to the 19th day of pregnancy, and those of a continuous irradiation from the first to the 19th day of pregnancy were followed. The irradiation effects on the chest limb bones of the irradiated embryos appeared as follows: the maximum percentages of agenesis and deformations were noticed on the tibia and the fibula on the 12th day after the irradiation. Then, with the help of micrometric measurements, reductions in all tested bones on the 11th, 12th, 13th, and 15th day after irradiation were registered, with the exception of the humerus, where values of the irradiated embryos, measured on the 13th day, were higher than those of the controls. The values of the continuously irradiated embryos were, in all tested bones, generally lower than in the control embryos. (auth)

46659 ROLE OF TISSUE INTERACTIONS IN THE REGENERATION PROCESSES OF SKELETAL MUSCLE. Dankova, A. A. Eksp. Khir. Anesteziol.; 14: 45-7(Jan-Feb 1969). (In Russian).

Experiments on rats confirm the possibility of restoration of a muscle organ from an autografted fragmented muscle tissue. To assess the role of the remaining muscle stump and connective tissue of the grafted bed their regeneration capacity was depressed by x irradiation with 2000 R. Degeneration of the muscle stump, which is separated from the newly formed muscle by a thin layer of the connective tissue, is shown. Depression of regeneration activity of the connective tissue and neuro-muscular link leads to slowing down of the graft growth. Neuro-trophic induction is indispensable for final differentiation of muscular fibres. (auth)

46660 BIOLOGICAL EFFECT OF LOW-INTENSITY UHF ELECTROMAGNETIC FIELDS. Serdyuk, A. M. (Scientific Research Inst. of General and Communal Hygiene, Kiev). Vrach. Delo; No. 11, 108-11(1969). (In Russian).

A total of 140 rats and 30 rabbits (males) were treated with UHF fields at intensities from 6 to 0.05 v/m for 180 days. The daily treatment had a duration of 10 to 12 hr. Cholinesterase activity decreased in the first period of treatment (30 days) at 6 to 0.5 v/m. UHF radiation at 0.2 and 0.05 v/m had no significant effect. Intensities of 6 to 0.5 v/m produced changes in the latent periods of conditioned reflexes. Electroencephalograms showed changes in rhythmic oscillations in electrical activity of the cortex. Continued treatment led to weakening of excitation and to fatigue in the nerve centers. Increase of the content of 17 Ketosteroids in the urine was a sign of stress reactions under the control of the hypothalamus–hypophysis–adrenal cortex system. A reduction of the number of leukocytes, reticulocytes, and eosinophils in blood was observed. Electrocardiograms showed an increase in the frequency of cardiac systoles in the first period of treatment, and later a decrease. Diminution of R and T waves in EKGs indicated distrophy in the myocardium. Apparently there was a stimulating effect of UHF on the vagus. In general, exposure to UHF was unfavorable for the organism. (JPRS)

46661 INFLUENCE OF GAMMA IRRADIATIONS (^{60}Co) ON THE DEVELOPMENT OF CHICK EMBRYOS. NOTE 1. Iozon, Doina; Onea, O.; Marcu, Teodora (Agronomic Inst., Cluj). Lucr. Stiint., Inst. Agr. Cluj, Ser. Med. Vet. Zooteh.; 25: 27-39(1969-70). (In Rumanian).

The cytologic modifications in the heart, liver, primitive kidney, and tegument of White Rock embryos induced by γ irradiations (^{60}Co) applied in continuous flow were studied. The various irradiation doses had stimulating, inhibitory, and lethal effects. A stimulating effect was obtained with doses of 12 R and 28 R at a rate of 0.4 R/hr in the 30 hr chick embryos. Doses of 50 R and 86 R at a rate of 0.7 R/hr were inhibitory for the development of 72 and 124 hr embryos. Lethal doses, for the 97 hr embryos, of 970 R and 1730 R at a rate of 10 to 18 R/hr had profound cellular and chromosomic effects. (auth)

46662 BRAIN STUDY IN BALLON-BORNE MONKEYS EXPOSED TO COSMIC RAYS. Haymaker, W.; Bailey, O. T.; Benton, E. V.; Vogel, F. S.; Zeman, W. (Ames Research Center, Moffett Field, Calif.). Aerosp. Med.; 41: 989-1002 (Sep 1970).

A study was made of the brains of six monkeys exposed to cosmic radiation during high altitude balloon flights lasting 9½ to 48 hours. Cosmic ray thindown tracks in the brains of the monkeys on the 48-hour flight were estimated to total approximately 10 tracks per cm^3 of brain tissue for cosmic ray particles $Z \geq 6$, and approximately 1 track per cm^3 of brain tissue for particles $Z \geq 20$. Acute vasculitis involving mainly cerebral meningeal vessels was noted in two of the monkeys autopsied relatively soon after one of the flights. The inflammatory cells were found in only short segments of the affected vessels. A consensus as to the cause of the vasculitis could not be reached. In another monkey two wide track lesions devoid of nerve cells were present in the cerebellar cortex. Presumably they antedated the flight, but in actuality the time of their occurrence and their causation could not be established. Narrow tracks were observed in the cerebellar cortex in all six balloon-borne monkeys and also in the control monkeys in about the same incidence. Narrow tracks produced by deuteron microbeams were taken into consideration in evaluation. For certain narrow tracks found in the balloon-borne animals, there was the question whether cosmic ray thindowns could have been responsible. No consensus was reached on this point. Iron-positive cells in excess were found in the region of the Purkinje cell layer of the cerebellum in two of the monkeys, but pathogenesis was obscure. (auth)

46663 EXPERIMENTAL OBSERVATIONS OF INTRACORPOREAL ^{90}Sr–^{241}Am/BERYLLIUM SOURCES SIMULATING RADIATION FIELDS FROM NUCLEAR-POWERED ARTIFICIAL HEARTS. Sandberg, Glenn W. Jr.; Huffman, Fred N.; Norman, John C. (Harvard Medical School, Boston. Boston City Hospital. Thermo Electron Corp., Waltham, Mass.). Ann. Thorac. Surg.; 9: 401-9 (May 1970).

The design of a source of neutron and γ radiation of a dose rate similar to that from a ^{238}Pu fuel capsule capable of powering a projected implantable artifical heart is described. Such sources have been implanted in dogs that have lived nearly 2 yr, have produced offspring, and have experienced no obvious ill effects of radiation except for lymphocyte chromosome abnormalities. (auth)

46664 MECHANISM OF THE BIOLOGICAL ACTION OF IONIZING RADIATION. Chebotar'ov, E. Yu.; Baraboi, V. A. Visn. Akad. Nauk Ukr. RSR; 33: No. 6, 86-8(1969). (In Russian).

The second UkrSSR Conference on the Mechanism of the Biological Action of Ionizing Radiation was held on 3 to 6 July, 1969 at L'vov. It was organized by the Scientific Council on Radiobiology of the Academy of Sciences USSR, the Scientific Council on Biophysics and Radiobiology of the Academy of Sciences UkrSSR, and the State University imeni I. Frank at L'vov. With respect to attendance and the extent of information covered (374 reports), it had the scope of an all union conference. Besides the plenary session, sessions on radiation biochemistry, radiation physiology, and general radiobiology were held. L'vov radiobiologists presented a number of reports dealing with the action of ionizing radiation on hemoglobin, albumin, actin, tropomyosin, myoglobin, and other important proteins. Immunobiological mechanisms of radiation injury and of radiation protection were also discussed. The formation of cancer in rats under the effect of neutron irradiation was reported, and data were presented on the action of neutron radiation on nucleic acid metabolism. The possibilities of using nucleic acids as radioprotective agents were discussed. Chromosome aberrations developing under the influence of various types of radiation were discussed in a number of papers. Results of studies on the biological action of radioactive isotopes were reported. The specific characteristics of the carcinogenic effect of isotopes and fast neutrons were discussed in several papers. Problems pertaining to accelerated entry of radioisotopes into the organism were discussed and considerable attention was given to chemical and biological protection against radiation. The development of radiation lesions under conditions of effective interference with their progress was reported and ideas on the effects of a number of physiologically active substances in stimulating the development of radiation lesions and in mobilizing endogenous protective mechanisms were of interest. (JPRS)

46665 RADIATION BREEDING OF THE DOMESTIC FOWLS. 5. THE ^{137}Cs γ-IRRADIATION OF HATCHING EGGS. Kashiwabara, Takao; Tanaka, Ryoichi; Matsumoto, Takuya; Koide, Kazuyuki; Kojima, Akira (Ibaraki Univ., Ami, Japan). Ibaraki Daigaku Nogakubu Gakujutsu Hokoku; No. 17, 7-11(Oct 1969). (In Japanese).

The effect of γ-ray dose on hatchability of eggs was studied using a ^{137}Cs(40 Ci) source. The eggs were exposed prior to incubation to γ rays at total doses of 100 R, 200 R, 400 R, 800 R, and 1,000 R at the dose rate of 26.0 R/min. Early embryonic death was not observed in any of the dose groups. There was a very low level of hatchability and rate of growth in the 100 R group as contrasted to the normal hatchability and growth rate shown in other groups. A clear understanding of the specific phenomenon of the 100 R group was not deduced from the results of this experiment. The body weight of 4-wk old female chicks in the 1,000 R group was smaller than that of the other groups but this difference was not significant. (NSA of Japan)

46666 LASER EXAMINES EYES. Simakov, Yu. Znanie Sila; No. 1, 22-4(1970). (In Russian).

The effect of the laser focused on the crystalline lens of the eyes of 30 frogs is discussed. It is noted that 30 minutes after laser exposure, the cornea remains undamaged, there are no apparent changes in the crystalline lens except for a small cloudy spot, and there was some damage to the retina. A day later changes began to take place in the crystalline lens. A ring cataract began to form, but instead of beginning at the point where the laser beam passed through the crystalline lens or at the poles, it began from the equator most removed from the part affected by the laser beam. In four days the cataract covered almost the entire lens. The questions of why the laser cataract develops so rapidly and why the irradiated part becomes cloudy last are discussed. In explaining these phenomena several new discoveries regarding the fine structure of the eye were made. It is noted that the frequency of the radiation emitted by the eye may depend on the structure of the crystalline lens fibers. The question of the possible important role played by the crystalline lens fibers as converters and amplifiers of this radiation is raised in connection with hypnotism. (auth)

46667 HYPOTHALAMIC REGULATION OF HEPATIC HEXOBARBITAL METABOLIZING ENZYME SYSTEM. Nair, V.; Brown, T.; Bau, D.; Siegel, S. (Michael Reese Hospital, Chicago. Chicago Medical School). Eur. J. Pharmacol.; 9: 31-40(1970).

Bilateral electrolytic lesions in posterior hypothalamus of male rats were shown to suppress the activity of the liver microsomal enzyme system metabolizing hexobarbital. Lesions in the caudate nucleus, hippocampus, preoptic area, or cerebral cortex did not influence the enzyme activity. The in vitro enzyme measurements in the post hypothalamic lesioned animals were supported by in vivo measurements of hexobarbital sleep time. In the case of caudate and hippocampal lesions, barbiturate sleep time was modified without any changes in the activity of the metabolizing enzyme. It is suggested that the activity of the enzyme system is under the regulatory control of posterior hypothalamus, possibly through the release of specific hypophyseal tropic hormones. This interpretation is consistent with the results from lesions, head x irradiation and hypophysectomy. (auth)

46668 BACKGROUND AND EVOKED ACTIVITY OF RABBIT VISUAL CORTEX NEURONS FOLLOWING THE APPLICATION OF AN ULTRA-HIGH FREQUENCY FIELD. Chizhenkova, R. A. Zh. Vyssh. Nerv. Deyateln. im. I. P. Pavlova; 19: 495-501(May-Jun 1969). (In Russian).

A one-minute action of an ultra-high-frequency (UHF) electromagnetic field (wavelength 12.5 cm, power flux density 40 mw/sm^2) on the head of the rabbit changes the frequency of the background activity in 52.4% of visual cortical neurones. The unit responses to light flashes are, as a rule, facilitated by the UHF field. Mechanisms of the UHF field effect on neuronal impulsation are discussed. (auth)

46669 COMPARISON OF LETHALITY AND CHROMOSOMAL DAMAGE INDUCED BY X-RAYS IN SYNCHRONIZED CHINESE HAMSTER CELLS IN VITRO. Dewey, W. C.; Furman, S. C.; Miller, H. H. (Colorado State Univ., Forth Collins). Radiat. Res.; 43: 561-81(Sep 1970).

Chinese hamster cells, synchronized by selecting mitotic cells either with or without a 2-hour pretreatment with Colcemid, were x irradiated during different phases in the cell cycle and then analyzed both for lethality (loss of colony formation) and for chromosomal aberrations. For the chromosomal analysis, each population of irradiated cells was sampled in metaphase at different time intervals after irradiation. To kill a certain fraction of the cells synchronized following Colcemid pretreatment or to produce a certain number of aberrations, cells in G_1 required doses 1.5–1.8 (dose modifying factors) times greater than cells irradiated in metaphase, and cells in mid to late S required doses 2.8–4.2 times greater than those irradiated in metaphase. The dose modifying factors for S phase decreased as comparisons

were made at levels of greater damage because the dose–effect response had a quasi-threshold or shoulder for S phase compared with a more linear relationship for metaphase and G_1 cells. The dose modifying factors based on lethality agreed within 15% of those based on chromosomal aberrations. Cells synchronized without Colcemid pretreatment gave the same qualitative results. However, Colcemid pretreatment prior to selecting the mitotic cells sensitized mitotic and G_1 cells in terms of both lethality and chromosomal damage. As suggested by lethality studies, cells irradiated in early S phase sustained a 2–3-fold increase in the number of chromosomal aberrations compared with the number sustained in cells irradiated in late G_1. These positive correlations between lethality and chromosomal aberrations support the hypothesis that damage in the chromatin structures is the main cause of x ray induced mammalian cell killing. (auth)

46670 EFFECTS OF X-IRRADIATION ON THE IMPLANTING CANINE EMBRYO. Tietz, W. J.; Phemister, R. D.; Stuart, B. P.; Smith, G. E.; Garner, R. J. (Colorado State Univ., Fort Collins). Radiat. Res.; 43: 554-60(Sep 1970).

The response of beagle embryos to an exposure of 100 R x rays on day 13, 16, 19, 22, or 25 of gestation was measured in terms of pre- and postnatal mortality, birth weight, and the incidence of developmental anomalies. Following irradiation on day 19, corresponding approximately to the primitive streak stage, few bitches produced litters than at any other exposure time. Postnatal mortality was markedly increased after exposure on day 16, 19, or 22. Irradiation at times from 16 through 25 days produced a significant reduction in birth weight, the greatest deficit occurring at 22 days. A rather high incidence of developmental anomalies was observed following irradiation on days 19 and 22, during the period of early organogenesis. From this it appears that the time of greatest radiosensitivity as measured by pre- and postnatal mortality occurred at about the primitive streak stage and immediately thereafter during early neurogenesis. In the dog this time shortly follows implantation. The overall pattern of response of the beagle embryo is thus similar to that reported in the mouse and rat but even more closely resembles that of the rabbit. (auth)

46671 RADIATION EFFECTS ON DEATH AND MIGRATION OF TUMOR CELLS IN MICE. Hofer, K. G. (Ohio State Univ., Columbus). Radiat. Res.; 43: 663-78(Sep 1970).

Inoculation of ^{125}I-iododeoxyuridine labeled tumor cells into nonradioactive hosts permits quantitative evaluations of migration and death of tumor cells in vivo. L1210 leukemia cells inoculated intraperitoneally into C3D2F1J mice die at a rate of 10 to 14% per day throughout tumor development. In vivo or in vitro x irradiation of L1210 cells drastically alters the kinetics and extent of tumor cell death. During the first two days after irradiation cell death is not significantly enhanced, even if large doses are administered. This is followed by a period of extremely rapid cell death. Depending on the radiation dose, this killing phase lasts for 2 to 6 days, and then the death rate returns to normal levels. Mice bearing tumor cells irradiated before transplantation live up to five days longer than control mice. However, mice subjected to whole body irradiation after tumor inoculation survive no longer than controls, even though such irradiations also produce large cytocidal effects. This may be due to radiation induced acceleration in tumor metastasis. Increased tumor cell migration can be demonstrated in mice irradiated shortly after tumor inoculation, and this effect is even more pronounced in mice irradiated before inoculation of nonirradiated L1210 cells. (auth)

Man

Refer also to abstracts 46575, 46607, 46617, 46619, 46623, and 46636.

46672 (AD-702524) NEUROPHYSIOLOGICAL AND BEHAVIORAL EFFECTS ON INCIDENTAL IRRADIATION OF "NORMAL" HUMANS. Final Report, May 1, 1968–August 1969. Boswell, R. S.; Feder, B. H.; Schaeflein, J. W. (Veterans Administration Hospital, Long Beach, Calif.); Sondhaus, C. A. (California Univ., Irvine). Contract DASA01-67-C-0136. 129p. (DASA-2378). CFSTI.

The effects of daily ^{60}Co γ irradiation on sensory detection of radiation, visual perception, and simple motor performance were investigated in normal human subjects during actual and sham irradiation of the apparently normal brain incidental to radiotherapy. The experiments were carried out in both dark and light adapted persons, and it was found that: sensory detection of radiation by humans is not reliable when the phosphene effect is eliminated; visual perception is differentially affected by radiation as a function of the dark-light adaptation state of the retina; and simple motor performance appears to be impaired when central portions of the brain receive about 50 Rad. In addition to these experiments, complex motor performance in multiportal pelvic-irradiated patients was assessed using a modified target gun. The results suggested no reliable posttreatment effects of ^{60}Co γ irradiation on complex motor performance under the specified test conditions. (auth)

46673 (TID-25492) RADIATION INDUCED GASTROINTESTINAL DYSFUNCTION AS A MODEL FOR THE STUDY OF ANOREXIA AND CACHEXIA OF NEOPLASTIC DISEASE. Michaelson, Sol M.; Martinedes, Barbara (Rochester Univ., N. Y. Dept. of Radiation Biology and Biophysics). [1969]. 50p. Dep. CFSTI.

The pathology of the acute radiation syndrome in man and animals is reviewed. The multiple clinical and pathophysiologic implications of exposure of animals or man to penetrating ionizing radiation, manifested by short-term and long-term responses of the gastrointestinal tract with vomiting, nausea, diarrhea, anorexia, and cachexia are considered. The uniform and predictive response that develops when the animal is exposed to ionizing radiation is suggested as a model for the study of anorexia-cachexia of cancer. The response of the gastrointestinal tract to radiation exposure and the anorexia-cachexia of cancer, although perhaps not exactly comparable, have enough similarities to warrant serious consideration of this model. Several mechanisms have been suggested for the gastrointestinal response to radiation exposure which suggest areas of approach that may be used in the elucidation of the anorexia-cachexia of neoplasia. It is pointed out that the possible role of immune factors, specifically autoimmunity, and of neuroendocrine function, as exemplified by the interplay of the hypothalamic-pituitary axis, offer intriguing possibilities for investigation. (138 references.) (C.H.)

46674 UNILATERAL RECURRENT PARALYSIS FOLLOWING CAROTID ANGIOGRAPHY BY MEANS OF THOROTRAST. Wenker, H.; Heilmann, H. P. Langenbecks Arch. Chir.; 325: 1020-3(1969). (In German).

A report is given on a patient who developed an isolated right recurrent nerve paresis 20 yr after open carotid angiography with Thorotrast. Radiography of the neck showed striate contrast deposits in the region of the right carotid artery. Measurement of impulse rates with the Siemens 1½" counter at the patient's neck showed gamma activity at a net rate of 1104 imp/min confirming the diagnosis of Thorotrast tumor. After the removal of pathological tissue around the right carotid artery, performed elsewhere, there was no change in the condition, clinically or radiologically. Postoperative measurement of the impulse rate showed 858 imp/min net. In view of this, operative intervention in similar cases is not considered useful. (auth)

46675 DYNAMICS OF CIRCULATING AUTOANTIBODIES IN PATIENTS SUFFERING FROM THYROID AFFECTIONS TREATED WITH ^{131}I AND WITH MEDICINAL AGENTS. Islambekov, R. K.; Aulov, D. M.; Nikolaev, A. I.; Platonova, L. B.; Aripov, D.; Tremasova, G. Ya. (Tashkent Inst. of Research of Local Medical Studies). Probl. Endokrinol.; 16: No. 2, 32-5(Mar-Apr 1970). (In Russian).

The results of investigations on the detection of circulating autoantibodies by the methods of passive hemagglutination and of binding of antiglobulin against the antigens of the thyroid gland, heart, liver, adrenal glands, and gonads, as well as against thyroglobulin in 20 patients with diffuse toxic goiter (severe form), treated with ^{131}I, and in 64 patients with various thyroid pathological conditions treated with medicinal agents are presented. Circulating antibodies against all the mentioned antigens were revealed in many forms of diseases of the thyroid gland. A conformity was noted between the autoantibody titre and the clinical condition of the patient. Immunological methods are suggested as an additional criterion for control of the therapeutic results in the patients with thyroid pathology. (auth)

46676 LASER IRRADIATION OF RETINAL TISSUE. Marshall, John; Mellerio, John (London Univ.). Brit. Med. Bull.; 26: 156-60(May 1970).

Definitions and explanations relating to the structure and operation of lasers are presented and a review of the studies performed during the three-year period following the first reported retinal lesion is given. Injury to the pigment epithelium and neural retina of the eye induced by pulsed and continuous wave lasers and the pathology of laser-induced lesions are discussed. Fifteen plates illustrating laser-induced lesions in tissues of the eye are included. The mechanisms of laser-induced lesions are also discussed for both pulsed and continuous wave lasers. The role of continuous wave lasers in the holographic study of retinal tissues is mentioned. (E.R.B.)

46677 LATE RADIATION EFFECTS IN THOROTRAST DEPOSITS. Wenz, W.; van Kaick, G. Langenbecks Arch. Chir.; 325: 1008-19(1969). (In German).

Thorotrast, a 22% suspension of thorium dioxide, was introduced

in 1928 to 1929 as x-ray contrast medium for visualizing vessels and cavities and for hepatolienography because it was deposited in the RES. The late effects observed today are caused by chronic foreign-body irritation and prolonged internal irradiation. Extravasations and intracavitary deposits lead to indurated Thorotrast granulomas and to cirrhosis of liver and spleen. Only rarely is it possible to remove such Thorotrast deposits radically. Two hundred and sixty cases of Thorotrast tumors have been published. They were mostly inoperable carcinomas of the liver and biliary passages. Kidney tumors following retrograde pyelography or malignant tumors in other organs after intracavitary application can occasionally be removed radically. Removal of the spleen is indicated only exceptionally in the presence of considerable subjective symptoms due to Thorotrast deposits. The number of Thorotrast sufferers in Germany now is estimated at several thousand. The collaboration of all doctors in collecting cases centrally for examination (Heidelberg, Homburg/Saar) is urgently requested. (auth)

46678 BIOLOGICAL EVALUATION OF RADIATION FROM "DKST" XENON LAMP. Dantsig, N. M.; Glebov, B. N. Svetotekhnika; No. 4, 15-17(Apr 1968). (In Russian).

Biological experiments on animals and calculated data based on published spectral curves for the biological effect of uv radiation in various spectral regions indicate that the mean dose of erythemal irradiation should not exceed the values of irradiance and dosage indicated in the "Instructions for Preventing Human Light Deficiency." For type DKST lamps, these conditions are fulfilled at illumination levels not exceeding roughly 100 lux. To avoid exceeding the permissible uv irradiance in the erythemal and, particularly, bactericidal spectral regions at higher illuminations, it is necessary to cover the light aperture of a DKST xenon lamp fixture with silicate glass at least 2 mm thick. This will strongly attenuate the irradiation in the short-wave region of the uv spectrum (to 3100 Å), with some attenuation in the near uv range. Permissible illumination levels can be refined when further work is done in this area, in particular, toward determination of the bacterial and vitamin D effects of xenon-lamp radiation. Operating experience with indoor xenon illumination installations must be studied. They must be evaluated from a health standpoint. (auth)

46679 RADIATION CATARACT. REVIEW. France, A. Cesk. Oftalmol.; 26: 118-27(Mar 1970). (In Czech).

The literature (47 references, mostly in English) on radiation-induced cataracts is reviewed with regard to factors affecting the development of such cataracts (e.g., age of patient, intensity of radiation, individual characteristics); the units used in measuring radiation; the causes of cataracts; job-related exposure to radiation and risks in the nuclear industry, including use of accelerators, and other industries using radiation; radiation dose problems; clinical symptoms and diagnosis of cataracts and treatment of patients; pathology and histology of cataracts and related biochemical changes; distinguishing between blindness due to lens damage and other types; and measures to prevent radiation exposure. (TTT)

46680 STATUS OF THE UPPER RESPIRATORY TRACT AND FUNCTION OF THE OLFACTORY ANALYZER IN PERSONNEL WORKING WITH NUCLEAR ACCELERATORS. Ostapkovich, V. E. Klin. Med. (Moscow); 47: 112-4(Feb 1969). (In Russian).

The state of the upper respiratory tract and function of the olfactory analyzer in 300 persons working with sources of ionizing radiation were examined. A group of 225 persons having no contact with radiation was also studied. In the first group there were found insignificant changes manifested by functional disturbances of circulation in the mucosa of the upper respiratory tract and by a reduced function of olfaction. The changes were not severe and did not affect the working capacity. (auth)

46681 BIOLOGICAL EFFECTS OF MICROWAVE AND RADIO-FREQUENCY RADIATION. Cleary, Stephen F. CRC Crit. Rev. Environ. Contr.; 1: 257-306(Jun 1970).

The biological effects of exposure to microwave and radio-frequency radiation are discussed with particular emphasis on the effects on man. The basis for the human exposures is also considered and a comparison is presented of standards that are presently in effect in several countries throughout the world. (auth)

Radiation Effects on Plants

Refer also to abstracts 46579, 46581, 46599, 46602, and 46603.

46682 CHANGE IN GROWTH RELATIONSHIPS IN SUNFLOWER PLANTS EXPOSED TO ^{60}Co RAYS. Savin, V. N.; Stepanenko, O. G. (Inst. of Agricultural Physics, Leningrad). Sb. Tr. Agron. Fiz.; No. 17, 93-101(1969). (In Russian).

A group of 27-day-old sunflower plants was irradiated with doses of 0.5 to 8 kR of ^{60}Co γ rays. A dose of 0.5 kR had virtually no effect on plant growth or development. A dose of 1 kR slowed growth somewhat, but accelerated development and increased seed productivity by 10 to 14%. A dose of 3 kR markedly slowed the growth of the main stem and disrupted the process of organ formation (change in shape of the anthodium, reduction in its size, and formation of lateral shoots from the auxiliary buds). Tests showed that doses of 5 and 8 kR were lethal. With increase in dose, the amount of dry substances and carbohydrates increased, exceeding at 5 to 8 kR the level of controls by 80 to 100%. (JPRS)

46683 SOME OBSERVATIONS ON THE RADIOSENSITIVITY OF CERTAIN VARIETAL AND HYBRID GENOTYPES OF CULTIVATED PEANUTS (ARACHIS HYPOGAEA L.). Emery, D. A.; Goardman, E. G.; Stucker, R. E. (North Carolina Agricultural Experimental Station, Raleigh). Contract AT(40-1)-1747. Radiat. Bot.; 10: 267-72(Jun 1970).

Five 280-seed samples of a uniform autogamous line of peanuts were adjusted to mean moisture percentages ranging from 3.22 to 5.72 percent and treated with 15 kR of x rays. Emergence was reduced to one seedling when pre-treatment moisture levels were held at 3.22 percent. When seed moisture percentages were raised to 3.97, 4.43, 5.11, and 5.72 percent, seedling emergence increased to 29 seedlings, 153 seedlings, 202 seedlings, and 205 seedlings, respectively. The radiosensitivity of parental and hybrid embryos of a single cross was studied in populations with near perfect emergence by adjusting seed moistures above thresholds known to be associated with severe seedling damage. Parental embryos were in general more radiosensitive than either of the reciprocal F_1 hybrids. (auth) (UK)

46684 X-RAY SENSITIVITY AND MODIFYING EFFECTS OF WATER IN CONIDIA OF ASPERGILLUS NIDULANS. Wilson, J. D.; Powers, E. L. (Univ. of Texas, Austin). Contract AT(40-1)-3408. Radiat. Res.; 43: 698-710(Sep 1970).

Modifications in the techniques for mounting bacterial spores on membrane filters and controlling their gaseous environment and water content during irradiation were applied in studies of the x-ray sensitivity of conidiospores of Aspergillus nidulans. The sensitivity of conidia exposed to water vapor over a range from 10^{-3} to 23 Torr equilibrium vapor pressure (EVP) prior to irradiation with 50 kVp x rays (10 krad/minute) in O_2 and N_2 was investigated. The responses of dry conidia are qualitatively similar to those observed in bacterial spores and vegetative bacterial cells; near saturation, conidia act more like the vegetative bacterial cell than the bacterial spore in regard to changes in radiation sensitivity. Three classes of lethal damage are observed. The inactivation constant (k_1) for O_2-independent damage (Class I) in very dry conidia (10^{-3} Torr EVP) is 1.088 min^{-1}. Class I damage is independent of cell water content as EVP increases to 10 Torr. Above 10 Torr, k_1 increases with increasing EVP to a value of 2.032 min^{-1} at 23 Torr. A postirradiation O_2 effect (Class III damage) is observed in very dry cells. The value of k_{11} is 3.231 min^{-1} at 10^{-3} Torr EVP. Increasing amounts of water serve to protect conidia from Class III damage; above about 1 Torr EVP this type of damage is not detected. The third type of damage occurs when O_2 is present at the time of irradiation (Class II). The role of water in Class II damage is more complex, being a protective one between 10^{-3} and 2 Torr EVP and a sensitizing one between 10 Torr and saturation. The results indicate that the processes that lead to radiation-induced death in eucaryotes are the same as those in procaryotes. (auth)

Radiation Effects on Microorganisms

Refer also to abstracts 46587, 46600, 46601, and 46628.

46685 STUDY OF INCREASED RESISTANCE TO ULTRAVIOLET RADIATION MECHANISM AFTER OMISSION OF ENERGY SOURCE FROM MEDIUM IN THE STRAIN ESCHERICHIA COLI 15 $T^-U^-HIS^-$. Slezarikova, Viera; Sedliakova, Milena (Biological Inst., Bratislava). Biologia (Bratislava); 25: 373-8(1970).

By means of short-term exposition of radioactive precursor the ability of Escherichia coli T−U−his−cells, growing in minimal medium with and without glucose, to incorporate ^{14}C/U/-adenosine was studied. In cells starving for glucose, this ability decreased by 97.4% in comparison with the control cells. Following incorporation of radioactive-labeled amino acid into proteins, it was found that RNA isolated from cells starving for glucose stimulated incorporation to 87%, with strong dependence on time. On the basis of the results, it is assumed that under conditions of glucose starvation, mRNA synthesis is rapidly slowed down, but simultaneously, decreased degradation of mRNA occurs. (auth)

46686 REPAIR OF RADIATION-INDUCED DAMAGE IN ESCHERICHIA COLI. I. EFFECT OF REC MUTATIONS ON

POST-REPLICATION REPAIR OF DAMAGE DUE TO ULTRAVIOLET RADIATION. Smith, Kendric C.; Meun, Dieter H. C. (Stanford Univ., Calif.). J. Mol. Biol.; 51: 459-72(14 Aug 1970).

The rec mutants of Escherichia coli K12 are more sensitive to ultraviolet radiation than corresponding rec^+ derivatives. Several of these rec mutants were tested for post-replication repair after uv irradiation. The mutants carried recA13, recA56, recB21, and recC22. Cultures growing exponentially were exposed to uv light (63 ergs/mm^2) and then labeled for ten minutes with ^{3}H-thymidine. The radioactive medium was removed and the culture divided into two portions, one of which was chilled while the other was reincubated in nonradioactive medium for various times. The DNA from the cells was then analysed on alkaline sucrose gradients. Labeled DNA from irradiated cells which had not been reincubated sedimented as short molecules. After reincubation, DNA from the recA mutants still behaved as short molecules, while DNA from rec^+, recB and recC cells assumed a position similar to that of DNA from unirradiated control cells. These results indicate that the two recA mutants tested were defective in their capacity for post-replication of damage induced by ultraviolet radiation. However, no deficiency in the recB and recC mutants was detected under the conditions used. Even in uvr^+ cells, which are capable of excision-dependent repair, the formation of short molecules could be demonstrated immediately after irradiation. However, after a 40-minute post-irradiation incubation before labeling with ^{3}H thymidine, only normal sized DNA was formed. In contrast, in a uvr^- strain, short molecules were still formed after a 90 minute post-irradiation incubation. These results indicate the excision-dependent repair can remove the lesions that lead to the synthesis of short pieces of DNA after ultraviolet-irradiation. Similarly, the exposure of ultraviolet cells to conditions of photoreactivation (which repairs pyrimidine dimers in situ) before labeling greatly diminished but did not completely eliminate the synthesis of short pieces of DNA. (auth)

46687 PHYSICAL STUDIES OF GLYCEROL PROTECTION AGAINST X-RAY INACTIVATION OF BACTERIOPHAGE. Donta, Sam T.; Freifelder, David (Brandeis Univ., Waltham, Mass.). Radiat. Res.; 43: 654-62(Sep 1970).

The effect of 33% (v/v) glycerol on x-ray induced inactivation, DNA double-strand breakage, and base damage of E. coli phage λ and single-strand breakage in Ps. aeruginosa phage B3 was investigated. The dose reduction factors are 2.4, 3.2, 1.6, and 3.1, respectively. The agreement between the dose reduction factors for DNA double- and single-strand breakages suggests that both processes probably occur by similar mechanisms and that the small protective effect of glycerol against x-ray inactivation of single-strand DNA phages is not due to a differential effect on single- and double-strand breakage, as proposed by Hotz. As would be predicted from earlier experiments which showed that the primary effect of anoxia + cysteine is to eliminate base damage, it was shown that survival curves for DNA breakage are identical to those for phage inactivation by x-irradiation under conditions of anoxia + cysteine both in the presence and absence of glycerol. (auth)

Radiosterilization and Radiopreservation

Refer also to abstract 46577.

46688 (AERE-R-6377) WHOLESOMENESS OF IRRADIATED FOOD: THE QUESTION OF INDUCED ACTIVITY. Rogers, F.; Whittaker, B. (United Kingdom Atomic Energy Authority, Wantage (England). Research Group). Jun 1970. 26p. Dep. CFSTI (U. S. Sales Only). UK 4s.

Includes appendix: The Measurement of Induced Activity in Fish and Meat, by D. Newton and L. Salmon.

In connection with applications for the exemption of certain food irradiation processes under the provisions of the Food (Control of Irradiation) Regulations (1967) evidence is presented concerning the extent to which ^{60}Co γ radiation might induce radioactivity in foods. It is concluded that any such activity would be lower than the naturally-occurring activity by a factor of at least 10^6 immediately after irradiation, or at least 10^8 after two or three days. (auth) (UK)

46689 INFLUENCE OF PRESERVATION METHODS ON THE COLOR AND OTHER QUALITY ATTRIBUTES OF GREEN BEANS (PHASEOLUS VULGARIS L.). Hildebolt, William Morton. Columbus, Ohio; Ohio State Univ. (1969). 173p.

Thesis.

Eleven cultivars were studied to determine the influence of blanching, canning, freezing, freeze-drying, and irradiation on the color and general quality of green beans. The beans were harvested by hand and all processes were performed in the laboratory using pilot plant equipment. Colorimetric and chemical measurements were made on the raw product and immediately after each blanching treatment and appropriate storage periods. The variables studied within each process were the maturity classification, blanching time and temperature, and storage period. Color was measured objectively by means of the Hunter Color and Color-Difference Meter and the Agtron M-30. In order to determine the relation between the colorimetric results and the amount of chlorophyll present in the green beans, an absorption spectrophotometric technique was used to quantitatively determine the chlorophyll content. The horticultural variables of cultivar and maturity were found to be the most influential of all the variables studied on the raw and processed green beans. Both the blanching and brining technique had little or no effect on the color of stored canned green beans. The blanching method did, although, greatly influence the degree of epidermal sloughing present in the canned product. Severe sloughing was induced by steam blanching. In the frozen product, the buffered blanching methods helped to protect the color of the beans better than the reference steam and water blanches. Similar results were found for the freeze-dried product. A consistently high quality product was obtained from both processes. The results of the analysis of the irradiated product indicated that the color was similar to that of a cooked product. In general, the overall quality of the irradiated product was poor, but if more control could have been exercised over the dosage level received by the green beans, a higher quality product probably would have resulted. The results of the pH, total acid, and Vitamin C analysis indicated that each processing variable influenced the chemistry of the green beans. The pH and the percent total acid varied slightly from one process to another and there was no relation between the inherent acidity and the chlorophyll retention of the green beans. Vitamin C was decreased by approximately one half during the canning process. Little change was noted in the ascorbic acid content of the raw, frozen, or freeze-dried products. (Diss. Abstr. Int., B) (F.M.M.)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

Refer also to abstracts 46307, 46386, 46388, 46450, and 47808.

46690 (BARC-487) THIN FILMS: THEIR PHYSICS AND APPLICATIONS. Dua, A. K.; Agarwala, R. P. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 55p. Dep. CFSTI (U. S. Sales Only).

Methods of preparation, techniques of thickness measurement, and characteristics of the films are reviewed. Emphasis is placed on properties which can not be measured in bulk, but can be profitably studied in thin films. Their applications, specially in optical, metallurgical, and electronic industries are discussed. Mathematical analysis is omitted in favor of descriptive discussions which though qualitative and much less precise have the advantage of making the review of interest to the non-specialist. (auth)

46691 (CEA-N-1315) DEVICE FOR SIMULTANEOUS MEASUREMENTS OF LENGTH AND RESISTIVITY UNDER IRRADIATION AT LOW TEMPERATURE. Weinberg, Claude; Conte, Rolland Rene; Dural, Jacques (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 34p. (In French). Dep. CFSTI (U. S. Sales Only).

By using a linear differential variable transformer (L.D.V.T.) in an in-pile irradiation capsule, it is possible to measure length variations in the flux. The operating conditions and the calibration of the transformer are described. The maximum length change measurable is 2 ± 1 mm; the sensitivity is 0.1μ. Resistivity changes are simultaneously measured to an accuracy of 2.10^{-4} with respect to the length. The capsule allows either in-flux measurements or annealing from 4 to 400°K after being irradiated. Some results obtained with uranium wires are presented as examples. (auth) (France)

46692 (ORNL-4548, pp 188-276) MATERIALS DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

BERYLLIUM FLUORIDES—$BeF_2-LiF-ThF_4$, corrosive effects on Hastelloy N at 677°C
—$BeF_2-LiF-ThF_4-UF_4-LiF_4$, corrosive effects on Hastelloy N at 700°C
CARBON—radiation effects on pyrolytic, in-pile
CHROMIUM A & S—$CR-Cr_3C_2-Ni$, deposition on Hastelloy N for corrosion protection
CHROMIUM CARBIDES—Cr_3C_2-WC, deposition on Hastelloy N for corrosion protection
COBALT A & S—$Co-Mo-WC$, deposition on Hastelloy N for corrosion protection
COBALT CARBIDES—Co_2C-WC, deposition on Hastelloy N for corrosion protection
GRAPHITE—crystal structure of, electron microscopic and x-ray studies on
—fabrication of high-density configuration of, for MSRE
—life-time and induced stresses in MSBR core, calculation of
—preparation and testing of low-permeability
—properties of reactor-grade, electric and physical
—radiation effects on, in-pile
—thermal conductivity of JOZ and Santa Maria grades
HASTELLOY N—aging behavior of titanium-modified
—coating with tungsten carbide-base layers for corrosion protection
—corrosion by molten salts under MSRE conditions
—corrosion by MSRE coolant, fuel, and blanket salts at 600 to 700°C
—corrosion by steam at 538°C
—mechanical properties of, effects of MSRE conditions on
—microstructure of titanium-modified
—radiation effects on properties of, relations of carbon and titanium contents with in-pile
—weldability of commercial
MOLYBDENUM—welding containers of, development of bismuth-resistant brazing filler metals for
SODIUM FLUORIDES—$NaF-NaBF_4$, corrosive effects on Hastelloy N at 677°C
STEAM—corrosive effects on Hastelloy N at 538°C
STEEL—corrosion by bismuth and molten salts, testing of commercial coatings for reduction of
TUNGSTEN—deposition on Hastelloy C, Inconel 600, and nickel by vapor deposition (J.R.D.)

46693 REACTOR MATERIALS. VOLUME 13, NUMBER 3. Final Issue. Simons, E. M.; Keller, D. L. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio: Battelle Memorial Institute (Fall 1970). 51p. GPO $0.70.

Research results on reactor materials are presented in nine sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 46694, 46700–46703, 46720, 46721, 46758, and 46788.

46694 METALLURGY OF REFRACTORY METALS. Peterson, J. H. Reactor Mater.; 13: 114-17(1970).

Developments resulting from research on Nb alloys, Mo alloys, W alloys, and V-base alloys are presented. (J.R.D.)

46695 PROSPECTS FOR FUEL-CYCLE ECONOMICS IN THE UNITED STATES. Hoffmeister, A.-J.; Houser, H.-G.; Smith, B. E. (Westinghouse Electric Corp., Pittsburgh). Energ. Nucl. (Paris); 12: 246-9(May-Jun 1970). (In French).

An attempt is made to envisage the total costs likely to be incurred in the exploitation of uranium during the next twenty years. These costs involve the production of UF_6 and the subsequent production of enriched uranium fuel, and the treatment of spent fuel. The credit arising from recovered plutonium is considered, as are the financial consequences of inflation. (auth) (France)

Corrosion and Erosion

Refer also to abstracts 47853, 47855, and 47932.

46696 (BARC-463) CURRENT TRENDS ON AQUEOUS CORROSION OF ZIRCONIUM ALLOYS: A REVIEW. Gadiyar, H. S. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 25p. Dep. CFSTI (U. S. Sales Only).

Zirconium and its alloys have found broad based application in pressurized and boiling water reactors for fuel cladding or for structural materials. When these alloys are considered, emphasis is laid not only on initial mechanical and physical properties, but also on the effects of corrosive attack, radiation damage, and hydriding. The development of zirconium alloys from considerations of corrosion in water and steam, mechanisms of film growth in this medium, effect of heat-treatment on these alloys, hydrogen absorption during corrosion, and behavior under irradiated conditions is reviewed. The recent trends in the development of the alloys for use in both water- and steam-cooled reactors have also been included. (auth)

46697 (WARD-4173-1) SODIUM TECHNOLOGY PROGRAM. Quarterly Progress Report for the Period Ending March 31, 1970. Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1970. Contract AT(30-1)-4173. 87p. Dep. CFSTI.

A detailed experimental program was written for the Carbon Equilibrium Loops (CELs) covering shakedown of the loops and metering systems, carbon meter calibration, and evaluation of C_s and M values. The design of the CELs, including the control panels and tie in of all on-line instrumentation, was completed; and a System Design Description (SDD) was written. A study of methods for hydrogen control was made. Cover gas stripping was compared with cold trapping, and allowances were made for loss of hydrogen by permeation through the loop walls. Even at low trapping efficiencies, cold trapping was much superior to cover gas stripping and will be used as the main method of hydrogen control. It will, however, be supplemented by cover gas stripping, and a gas chromatograph will be installed for cover gas monitoring. The effects of sodium exposure on brazed Inconel 718 fuel pin grid-type samples are being investigated. Results of weight change and metallography investigations have indicated that at 1200°F, Inconel 718 loses weight due to loss of nickel and chromium; and Nicrobraz 50 loses nickel and phosphorus when exposed to flowing, low oxygen sodium. The sodium Pre-Exposure Loop (PEL-1) operation was terminated after 5049 hours with mechanical property type test samples of Type 316 stainless steel at 1200 and 1338°F. Disassembly is in progress while design and fabrication of components for the second operation of the PEL-1 is proceeding. Check-out operations of the stress-relaxation and creep-rupture systems with flowing sodium and a test sample at 1200°F have been performed. Modifications to the loop cold trap system are being incorporated due to cover gas accumulation pulled into the loop as a result of cover gas and

sodium mixing in the test chamber. Assembly of the sodium loop for the strain controlled fatigue testing system is in progress. Check-out of the test machine has been performed, and it appears to be satisfactory for a wide variety of test cycles. (auth)

46698 (WARD-4173-2) SODIUM TECHNOLOGY PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1970. Ray, William E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Aug 1970. Contract AT(30-1)-4173. 46p. Dep. CFSTI.

Research results are summarized for work on interstitial carbon and nitrogen transport by sodium in stainless steel and on sodium corrosion of weldments and brazements. Results are also reported on evaluations of mechanical properties of structural materials in sodium. (J.R.D.)

46699 MECHANISM FOR THE ACID CORROSION BEHAVIOR OF NEUTRON-IRRADIATED URANIUM. Kindlimann, L. E. (Allegheny Ludlum Steel Corp., Brackenridge, Pa.); Greene, N. D. Corrosion; 26: 189-92(Jul 1970).

Neutron-irradiated uranium (e.g., a reactor fuel rod) dissolved more rapidly in nitric acid than did depleted, unirradiated uranium. In sulfuric acid, however, the two materials corroded at almost the same rate. These unusual corrosion characteristics were investigated by electrochemical and corrosion measurements on uranium-fissium alloys, which chemically simulated the irradiated material through the addition of stable nucleides of the fission products. The study has shown that these unusual effects are related to surface enrichment of noble metal fission products during corrosive attack. (auth)

46700 CORROSION OF BASE-METAL ALLOYS IN AQUEOUS AND GASEOUS MEDIA. Berry, W. E. Reactor Mater.; 13: 135-8(1970).

Results of research on Al, ferrous alloys, Ni alloys, and Zr alloys are summarized. (J.R.D.)

46701 OXIDATION OF REFRACTORY METALS. Allen, B. C. Reactor Mater.; 13: 139-42(1970).

Results of research on oxidation of Nb, Hf, Ta, W, and Cr are summarized. Work on coatings for refractory alloys such as T-222, FS-85, and other Nb-Ti alloys are reported along with work on corrosion of Hf alloys and Mo alloys. (J.R.D.)

46702 CORROSION BY LIQUID METALS AND FUSED SALTS. Simons, E. M. Reactor Mater.; 13: 143-52(1970).

Results of research on corrosion of stainless steel-sodium systems and steel-fused salt systems are summarized. Corrosion test results are also included for V-Na systems and Mo-Na systems. Research on corrosion in Rankine cycle space power systems is reported emphasizing lithium and potassium effects on refractory containment materials. Work directed toward molten U fuel containment and corrosion of reactor materials by fused fluoride salts is outlined. (J.R.D.)

46703 CLADDING BEHAVIOR IN LOSS-OF-COOLANT ACCIDENTS. Rosenberg, H. S. Reactor Mater.; 13: 153-4(1970).

Results of tests on internally pressurized stainless steel tubes at 950 to 1190°C and 304 to 1500 psig are presented. Other work on stainless steel fragmentation in thermal shock is reviewed along with sodium-water reactions in tubes. (J.R.D.)

46704 BEHAVIOR OF STAINLESS STEELS AND OF NICKEL OR ZIRCONIUM ALLOYS IN THE PRIMARY SYSTEMS OF NUCLEAR POWER PLANTS. Herbsleb, G. Mitt. Ver. Grosskesselbetr; 50: 132-51(Apr 1970). (In German).

Results of surveys on the resistance to corrosion of stainless steel, nickel, and zirconium alloys in reactors cooled with light water (pressurized water, boiling water, or steam reactors) or with CO_2 are presented. The risk of corrosion of stainless steels and nickel alloys by local attack (pitting, intercrystalline corrosion and tension cracks) is emphasized. (auth)

46705 OXIDATION OF THIN NIOBIUM FILMS AT LOW TEMPERATURES. Klechkovskaya, V. V. (Inst. of Crystallography, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 15: 299-301(Sep-Oct 1970).

Translated from Kristallografiya; 15: 388-91(Mar-Apr 1970).

An electron-diffraction investigation of thin niobium films was carried out during the process of low-temperature oxidation. It was shown that the oxidation process takes place due to the appearance of defects in the oxygen and metallic sublattices. The structures of the cubic phases having identity periods of a = 4.39 ± 0.01, a = 4.43 ± 0.01, and a = 3.88 Å were determined. (auth)

Preparation and Fabrication

Refer also to abstract 46210.

46706 (UCRL-50895) LEAD. Du Rose, A. H.; Blum, William (California Univ., Livermore. Lawrence Radiation Lab.). 21 Jul 1970. 20p. Dep. CFSTI.

The principles, as well as operating conditions and characteristics, of the electrodeposition of lead from fluoborate, fluosilicate, and sulfamate baths are discussed. Lead-tin alloy plating, the use of lead for anodes, mechanical properties of lead and lead alloys, and the stripping of lead and lead-tin deposits are also discussed. (90 references.) (J.G.B.)

46707 (ZJE-81) PROBLEMS OF MANUFACTURE AND WELDING OF STRUCTURAL EQUIPMENT OF AUSTENITIC STEELS FOR NUCLEAR REACTORS. Halaburda, J.; Masek, Z.; Matejovic, K.; Tosovsky, B. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 13p. Dep. CFSTI (U. S. Sales Only).

Aspects of austenitic steel fabrication equipment for nuclear reactors are discussed. The possibilities of production of austenitic steels in the ČSSR are outlined, particular reference is made to the possibility of effectively producing exceptionally large ingots not produced in the ČSSR up to the present, data are quoted of the isotropy of the mechanical properties of plates 100 mm thick, the influence of neutron radiation on the mechanical properties is mentioned and the problem of heat treatment of weldments is studied. Exceptional attention is devoted to the problems of welding. Matters presented in particular are the resulting findings, gained experience, and the method used in the welding of the supporting cylinder for the first Czechoslovak nuclear reactor which is a large size body with walls 25 to 120 mm thick, with which so far no manufacturer in the ČSSR had any experience. (auth)

46708 PROCESS FOR THE SHEATHING OF TUBULAR NUCLEAR FUEL ELEMENTS. Granta, S. Canadian Patent 845,370. 30 Jun 1970. Priority date 4 Aug 1966, Italy.

A process is described for sheathing the inside of tubular nuclear fuel elements with a zirconium alloy and obtaining of firm bond between the two. A metallic pipe is contracted by cooling with liquid nitrogen and inserted into the tubular fuel element. The pipe is then expanded by heating to room temperature. In the next step the sheath is heated to 850°C by a suitable means while the outside of the fuel element is cooled to cause interdiffusion at the interface between the sheath and the fuel element. X ray analysis has shown the non-existence of preferential crystalline orientations. (F.S.A.)

46709 PRODUCTION OF HN75 ALLOY TUBES FOR NUCLEAR POWER PLANTS. Suzuki, Jun; Yui, Shinroku; Deguchi, Hideo; Ota, Kunio (Sumitomo Metal Industries, Ltd., Osaka). Sumitomo Kinzoku; 22: 229-38(Apr 1970). (In Japanese).

In Japan, a number of water-moderated and water-cooled types (BWR and PWR) nuclear power plants are being constructed. These plants, of course, require pipes and tubes of various kinds. For instance, there are the HN75 alloy tubes (Inconel 600) used for steam generators in PWR. They form an integral part of the unit. From the standpoint of such a critical application, as well as the nature of the alloy, the manufacture of these HN75 tubes needs extreme care. After much experimentation a production process has been established which ensures quality of these tubes. The production method, quality control, and test results on the products are described. (auth) (Japan)

Properties Evaluations

Refer also to abstracts 46393, 46412, 46431, 46435, 46447, 47855, 47867, and 47892.

46710 (BARC-448) PRECIPITATION KINETICS OF ZIRCONIUM HYDRIDES IN ZIRCONIUM. Sivaramakrishnan, K. S. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 17p. (CONF-691128-2). Dep. CFSTI (U. S. Sales Only).

From 23rd Meeting of the Indian Institute of Metals, Bombay, India.

Hydrogen embrittlement in zirconium-base alloys is known to occur due to formation of zirconium hydride precipitates. As zirconium base alloys find considerable application in nuclear technology, a study of the nucleation and growth kinetics of zirconium hydrides is of great interest. The precipitation kinetics of zirconium hydride when sponge zirconium containing 200 ppM hydrogen is solution treated and later annealed at 220 to 350°C is described. Results indicate that the heterogeneous reaction involving nucleation and growth of the hydride phase in sponge zirconium is governed by Johnson-Mehl equation; the value of time

exponent component being 1.44. The temperature dependence of the reaction rate constant gives an activation energy of 7.3 kcal/g-mole which compares favorably with diffusion activation energy of hydrogen in zirconium. The precipitation of hydrides is therefore believed to be diffusion controlled at 200 to 350°C. (auth)

46711 (BARC-458) INTERNAL FRICTION DUE TO OXYGEN-SUBSTITUTIONAL IMPURITY ATOM COMPLEXES IN ZIRCONIUM. Mishra, S.; Asundi, M. K. (Bhabha Atomic Research Centre, Bombay (India)). 1970. 24p. (CONF-691128-1). Dep. CFSTI (U. S. Sales Only).

From 23rd Meeting of the Indian Institute of Metals, Bombay, India.

The effects of W, Fe, and Si in combinations with O as impurities on internal friction in Zr were investigated. Data are presented tabularly and discussed. It was found that W and O are both required for the appearance of an internal friction peak. Iron–O complexes also give rise to internal friction peaks as do Si–O complexes. (J.R.D.)

46712 (FOA-4-4434-23) SOME HIGH-PRESSURE PROPERTIES OF URANIUM AND OTHER ACTINIDES. Leman, G. (Forsvarets Forskningsanstalt, Stockholm (Sweden)). Jul 1970. 48p. (In Swedish). Dep. CFSTI (U. S. Sales Only).

A high-pressure-cell was modified for accurate determination of electrical resistance and pressure. The equipment used has three separate electrical circuits. It was designed for measurement of the resistance of uranium up to about 600 kbars. Any changes in electrical resistance from phase conversion at 500 kbars as has been proposed from shock wave experiments were not observed. Compression data for uranium from different experiments are discussed and analyzed. From the variation in the periodic system of some volume-dependent quantities values for the heavy elements are suggested. (auth) (Sweden)

46713 (IS-RIC-4) RARE-EARTH METALS IN STEELS. Kippenhan, Nancy; Gschneidner, Karl A. Jr. (Iowa State Univ. of Science and Technology, Ames. Rare-Earth Information Center). 1 Mar 1970. 61p. Dep. CFSTI.

For Molybdenum Corp. of America, New York.

The effectiveness of rare-earth additions to steel depends on the type of steel, on the amount of rare earth added, on the method and time at which the rare earths are introduced, and sometimes on which particular rare-earth metal is used. In general, a mixture of the rare-earth metals is added, rather than the individual element. The emphasis of this survey on the effects of rare-earth additions to steel is on the literature published during the 1960's, since excellent reviews of the earlier literature are available. This survey presents several general facts about the effect of rare earths on steel and some specific points, which may or may not have general utilization in a particular class or classes of steels. In general the rare earths impart beneficial effects on the steel, but sometimes can have a deleterious effect. The rare earths have a strong influence on sulfur and/or sulfides; the trend is toward sulfur removal and spheroidization of sulfides or oxysulfides. They tend to improve the oxidation and scaling properties of nominally oxidation resistant steels. The rare-earth metals improve the mechanical properties of the steels. In general the room temperature strength and impact properties, the high temperature creep-rupture properties and hot workability are better for rare earth-treated steels than untreated steels. The amount of rare-earths added is critical. Too little and little or no benefit is realized. Too much and they have deleterious effects: increased brittleness, lower strength, and poor high temperature properties. The control of rare-earth additions, as the control of other alloying agents, is very important and must be maintained if consistent high quality steels are to be manufactured. The addition of rare earths to the ladle appears to give the most beneficial effects. This is especially true for high alloy steels. Some success has been realized, however, for low alloy steels when the rare earths are added to the mold, rather than in the ladle. (G.M.C.)

46714 (NRL-7152) REASSESSMENT OF FRACTURE-SAFE OPERATING CRITERIA FOR REACTOR VESSEL STEELS BASED ON CHARPY-V PERFORMANCE. Loss, F. J.; Hawthorne, J. R.; Serpan, C. Z. Jr. (Naval Research Lab., Washington, D. C.). 8 Sep 1970. 28p.

Fracture-safe operating criteria for commercial nuclear pressure vessels based on fracture analysis diagram procedures and Charpy-V energy trends are reappraised with respect to the effects of thick-section mechanical constraint and low Charpy-V shelf energies resulting from neutron irradiation. Comparisons of the Charpy-V test with the more definitive dynamic tear test procedures indicate the former to be an acceptable means of assessing the fracture toughness of A533-B steel. The mechanical constraint associated with 12-in. thicknesses of this steel suggests the addition of 70°F (39°C) to the existing criterion requiring vessel operation above NDT + 60°F (33°C). Ratio analysis diagram procedures are shown to be useful in interpreting Charpy-V shelf level data obtained from vessel surveillance programs in terms of critical toughness levels relating to brittle fracture. (auth)

46715 (SC-RR-70-407) THE LOW STRAIN TENSILE BEHAVIOR OF MULBERRY ALLOY (7.5 PERCENT Nb, 2.5 PERCENT Zr, BAL. U). Albright, Charles E. (Sandia Labs., Albuquerque, N. Mex.). Jul 1970. 45p. Dep. CFSTI.

The stress-strain response of polycrystalline, γ-quenched Mulberry alloy (uranium, 7.5% niobium, 2.5% zirconium) was studied as a function of strain rate and compared to equilibrium stress-strain tests performed by allowing the strain to reach a maximum value at incrementally increasing stresses. Equilibrium stress-strain tests were also performed on samples prestressed to various values. Sheet tensile specimens were held at various states of strain in an x-ray diffractometer to determine crystal structural changes during deformation. Prestressed tensile bars were sectioned and examined metallographically and with the x-ray diffractometer. Two linear regions were observed in the equilibrium stress-strain tests; a low stress region with a slope of 5.3 to 5.5×10^6 psi, and a region above 40,000 psi with a slope of 3.3×10^6 psi. Finite strain rates tended to increase both slopes. The diffractometer experiments yielded plots of lattice parameter versus strain which showed a shift from a body-centered cubic structure of the γ_i phase, to a body-centered tetragonal structure of the γ_0 phase between 1 and 3% deformation. A semiempirical equation was developed which describes the equilibrium stress-strain behavior of Mulberry in terms of a stress induced phase transformation. (auth)

46716 STUDY OF CHEMICAL GAS-SOLID INTERACTIONS BY MOLECULAR BEAM TECHNIQUE. III. REFLECTION OF A RARE GAS BEAM FROM A TUNGSTEN SURFACE IN PRESENCE OF CO_2. Lintz, Hans-Guenther; Pentenero, Andre; Le Goff, Pierre (Centre National de la Recherche Scientifique, Villers-les-Nancy, France). J. Chim. Phys.; 67: 494-7(Mar 1970). (In French).

The reflection of a rare gas beam from a polycrystalline tungsten ribbon in presence of different isotropic gases was studied. The results show that only the gases able to form a chemisorbed oxygen layer influence the proportion of the incident beam atoms which are specularly reflected. In the case of CO_2, this influence may be described by a simple mathematical model developed from a kinetic model of CO_2 adsorption proposed by Walsh, Quets, Graff and Ladd. (auth) (France)

46717 STUDY OF CHEMICAL GAS-SOLID INTERACTIONS BY MOLECULAR BEAM TECHNIQUE. II. REFLECTION OF A RARE GAS BEAM FROM A TUNGSTEN SURFACE IN PRESENCE OF OXYGEN. Lintz, Hans-Guenther; Pentenero, Andre; Le Goff, Pierre (Centre National de la Recherche Scientifique, Villers-les-Nancy, France). J. Chim. Phys.; 67: 487-93(Mar 1970). (In French).

The study of the reflection of a rare gas beam from a polycrystalline tungsten ribbon in the presence of oxygen shows that there is preferential reflection of beam atoms from a (bare) metallic surface and that the scattering distribution is strongly influenced by the degree of coverage of this surface. The results are interpreted by a geometric model of two chemisorbed oxygen states and the variations of the degrees of coverages can be measured as a function of oxygen pressure and ribbon temperature. These variations are compatible with a kinetic model proposed by Schissel and Trulson after alteration of certain parameter values of their model. (auth) (France)

46718 DIFFUSION DATA. VOLUME 4, NO. 2, 1970. Woehlbier, F. H. (ed.). Diffus. Data; 4: 185-295(1970).

References and information are included on diffusion in liquid and solid metals and alloys, intermetallic compounds, halides, and in miscellaneous substances. References and information are also included on experimental techniques for determining diffusion. (J.R.D.)

46719 EFFECT OF THE NORMAL TO THE SUPERCONDUCTING STATE TRANSITION ON STRESS RELAXATION IN LEAD CRYSTALS. Suenaga, M.; Galligan, J. M. (Brookhaven National Lab., Upton, N. Y.). Scr. Met.; 4: 697-704(Sep 1970).

The electron drag effects on dislocation motion in superconductors were investigated. Tensile specimens of single-crystal lead rods were used. The tests were performed at liquid He temperatures. It was found that stress changes upon changing from normal-to-superconducting state are dependent on the time after stopping loading in the normal state. This dependency is interpreted as evidence for an electron viscosity effect. (J.R.D.)

46720 METALLURGY OF COMMON CLADDING AND STRUCTURAL MATERIALS. Kangilaski, M. Reactor Mater.; 13: 107-13(1970).

Developments resulting from research on Zr alloys, stainless steels, Ni-base alloys, and pressure vessel steels are summarized. (J.R.D.)

46721 DIFFUSION STUDIES. Ashurst, A. N. Reactor Mater.; 13: 118-23(1970).

Developments resulting from research on diffusion in nuclear fuels, diffusion in refractory metals, diffusion in reactor structural metals and metallic systems, and diffusion of interstitials and gases in metals are summarized. (J.R.D.)

46722 HYDROGEN EMANATION AND DISTRIBUTION IN METALS AND ALLOYS. Toy, S. M. (Douglas Aircraft Co., Long Beach, Calif.); Phillips, A. Corrosion; 26: 200-7(Jul 1970).

Hydrogen emanation and distribution (at microstructural features) down to one micron size were observed in 250-grade 18 Ni maraging steel weldments and in titanium-6Al-4V. A neodymium hydrogen metal detector system was used to locate and estimate the amount of hydrogen emanation; this system operated on the basis of a chemical reaction. Neodymium, or a similar rare earth metal, was reacted with the emanating hydrogen at a temperature of 29°C or higher to form a metal hydride. A thin neodymium film was evaporated on the polished and etched metal or alloy surface to be examined. This metal film was optically transparent at the H_2 reaction sites where NdH_2 was formed; therefore, the microstructural features of the metal surfaces was directly correlated to the H_2 emitting sites. The NdH_2 reaction nodules appeared black when observed with an optical microscope. By measuring the size of the reaction sites and the thickness of the film, the amount of hydrogen reacted with the Nd to form NdH_2 can be theoretically calculated. Assuming a reasonable metal film thickness at 2800 Å, a NdH_2 reaction site one micron in diameter revealed approximately 4 ppM H_2 emanating from an austenite island in 18 Ni maraging steel weldment. A similar type calculation for NdH_2 reaction sites found on a Ti-6Al-4V specimen with 500-ppM H_2 indicated the amount of hydrogen emanation to be 30-ppM H_2. In this case, hydrogen was found to emanate strongly from the α/β interface. The H_2 sensitivity and resolution of this detection system were further improved by resolving individual NdH_2 nodules with a scanning electron microscope. Theoretical calculation of the hydrogen diffusing from the metal substrate into the Nd film at the reaction temperature was of the same order of magnitude with values calculated for the amount consumed at the NdH_2 reaction sites. (auth)

46723 STATE OF NICKEL ATOMS IN A NICKEL-MOLYBDENUM ALLOY. Kalinovich, D. F.; Kovenskii, I. I.; Smolin, M. D. (Inst. of Problems in Materials Science, Kiev). Sov. Phys.-Solid State (Engl. Transl.); 12: 723-4(Sep 1970).

Translated from Fiz. Tverd. Tela; 12: 929-31(Mar 1970).

The electrotransfer of Ni in an alloy with 23 at. % Mo was investigated at 1100 to 1300°C, using ^{63}Ni deposited on alloy wires as a tracer. Specimens were annealed by passing an electric current which set up a field. The resulting diffusion coefficients has an exponential dependence on $1/T$, with $D_0 = 0.12\ cm^2/sec$ and $E = 47{,}400$ cal/mole. The effective ionic charge of the migrating component Z^* falls in the range -4.01 to -4.46. (D.L.C.)

46724 STRAIN CYCLING OF NIOBIUM SINGLE CRYSTALS. Doner, Mehmet. Pittsburgh; Univ. of Pittsburgh (1969). 203p. University Microfilms Order No. 70-7876.

Thesis.

Single and multiple slip oriented crystals of niobium, a body-centered cubic metal, are cyclically strained in tension-compression around zero mean strain, in air and at room temperature. Crystals deforming by single slip show a well defined two-stage fatigue hardening. The first stage has a very low hardening rate, and is absent in crystals of multiple slip orientations. In the latter, the rate of cyclic hardening, for a given strain amplitude, is related to the amount of secondary slip. An interpretation of the hardening results is attempted and compared with the behavior of copper single crystals. The observed slip planes are in agreement with the predictions based on the asymmetry in the critical resolved shear stress on {211} planes. It is also found that whichever systems are activated during the first ¼ tensile cycle seem to operate all throughout the test, even though other systems become more favorable in the compression half cycles. In single slip crystals kink bands begin to form during the rapid hardening stage. This shows up as asterism in Laue back reflection photograms. Later on, after cycling into saturation, they become optically visible on and around the side face. The kink bands cause intense slip localization in their vicinity, which results in extreme surface disorder. Eventually, both crystallographic and non-crystallographic cracks initiate in these regions. The crystallographic cracks initiate along the traces of primary slip; non-crystallographic cracks seem to be associated with the folds in the kink bands. Kink bands are either completely absent or weakly detectable in crystals deformed by multiple slip. Consequently, the surface is less disordered. No cracks can be found in these crystals after cyclic deformations which normally initiate cracks in single slip crystals. (Diss. Abstr. Int., B)

46725 CALCULATION OF MIGRATION ENERGIES AND BINDING ENERGIES FOR TUNGSTEN ADATOMS ON TUNGSTEN SURFACES. Wynblatt, P.; Gjostein, N. A. (Ford Motor Co., Dearborn, Mich.). Surface Sci.; 22: 125-36(Aug 1970).

Migration energies and binding energies were calculated for adatoms on tungsten surfaces by means of a pairwise interaction model. The inclusion of significant relaxation effects in these calculations eliminated previous qualitative discrepancies between the calculated and the measured orientation dependence of the migration energies. The remaining discrepancies are rationalized by invoking both bond strengthening and bond weakening hypotheses for atomic interactions at the surface. (auth)

46726 ELECTRON MICROSCOPIC OBSERVATION OF THE SHAPE OF FIELD EMISSION CATHODE TIPS. Okuyama, Fumio (Nagoya Inst. of Tech., Japan). Surface Sci.; 22: 1-11(Aug 1970).

The shape of carbon-adsorbed, carburized, and oxidized tips, which were obtained by heating tungsten emitters in a field emission microscope evacuated by a rotary pump and an oil diffusion pump, was observed by electron microscopy. It was found that the shape of these tips differed markedly depending on the exact treatment imposed on the sample. Experiments utilizing the models having cubic and hexagonal structures were attempted for carbon-adsorbed and carburized tips and it was found that the shape of carbon-adsorbed and carburized tips could be explained on the basis of the crystal structures of W and WC. It was, therefore, conjectured that the shape of the originally cubic tungsten tip changed to the hexagonal type as the crystallization of the hexagonal WC layer proceeded. (auth)

46727 ADSORPTION OF HYDROGEN ON TUNGSTEN (112); CO-ADSORPTION OF HYDROGEN WITH OXYGEN. Adams, D. L.; Germer, L. H.; May, J. W. (Cornell Univ., Ithaca, N. Y.). Surface Sci.; 22: 45-68(Aug 1970).

The adsorption of hydrogen and the co-adsorption of hydrogen with oxygen on W(112) were studied by means of flash desorption mass-spectrometry, work function, and LEED measurements. After saturating a clean surface with hydrogen, three desorption peaks could be identified at peak temperatures of approximately 600, 500, and 400°K. The kinetics of hydrogen adsorption were considered through measurements of the amounts of adsorbed hydrogen in each of the three binding states after different exposures. A plot of change in work function versus total coverage had changes in curvature which could be correlated with the occurrences of particular desorption peaks. The maximum work function increase was 0.72 eV. After exposing a clean surface to oxygen, the adsorbed oxygen could not be reduced by hydrogen at the experimental temperatures and pressures. Adsorption of hydrogen upon a surface containing pre-adsorbed oxygen raised the work function above the increase produced by oxygen alone. The increase produced by saturation hydrogen exposure fell linearly with oxygen precoverage from the clean surface value of 0.72 eV to zero at $\theta_{oxygen} = 1$. The saturation amount of hydrogen adsorbed also fell linearly with oxygen precoverage to zero at $\theta_{oxygen} = 1$. On a surface containing both oxygen and hydrogen a rearrangement of the adsorbed species was produced by the electron beam at room temperature, or in the absence of the beam by heating to about 400°K. The heterogeneity of single-crystal surfaces is discussed in terms of the formation of ordered adsorbate structures and also of site heterogeneity, with particular reference to the hydrogen/tungsten system and to present results on tungsten (112). (auth)

46728 MICROYIELDING AND FAILURE MECHANISMS IN DUCTILE AND BRITTLE POLYCRYSTALLINE MOLYBDENUM. Thornley, J. C. (Univ. of Bradford, Eng.); Wronski, A. S. Acta Met.; 18: 1053-60(Oct 1970).

The initiations of slip, fracture, and rupture in tension were studied in sintered and cast molybdenum specimens in the temperature range 77 to 474°K using optical and scanning electron microscopy. The ductile-brittle transition temperatures, T_T, were ~212°K for the sintered material and ~160°K for both coarse and fine-grained cast material. For all batches, at all test temperatures, slip lines were first observed at stresses between 0.35 and 0.50 of the yield stress (in tension, σ_Y, or compression,

σ_{Y^S}). In cast materials brittle fracture took place at stresses equal to σ_{Y^C}, but in the sintered specimens at any stress between the microyield stress, σ_M, and σ_{Y^C}. Slip lines crossing grain boundaries, cross-slip, slip on more than one system were observed in ductile and brittle, sintered and cast, tensile specimens strained to stresses between σ_M and σ_{Y^C}. Non-propagating surface microcracks were detected only in ductile specimens at stresses greater than σ_Y and only in one sintered specimen at a stress lower than σ_Y. The majority of these cracks was intergranular and approximately normal to the tensile axis. In sintered material they were more numerous and were nucleated concurrently with increasing plastic deformation (up to ~30 per cent nominal strain). Although crack nucleation was predominantly intergranular, crack propagation was mainly transgranular in cast specimens and both transgranular and intergranular in sintered specimens. Above the fracture mode transition temperature, in sintered material, voids were formed predominantly at grain boundaries and rupture took place by the pulling out of the fibre-like grains and the shear of the inter-void fibres. (auth)

46729 INTERACTION OF Mo–Zr AND Mo–Ti ALLOYS WITH A GASEOUS MEDIUM CONTAINING CARBON AND OXYGEN. Ageev, N. V.; Egoshina, S. G.; Model, M. S. (Inst. of Metallurgy, Moscow). Dokl. Akad. Nauk SSSR; 190: 1345–7(21 Feb 1970). (In Russian).

It was observed earlier that solid solutions of Mo–C–Zr and Mo–C–Ti may coexist in molybdenum under a relatively stable equilibrium. This study revealed that this equilibrium is disturbed by heating the melts in a gaseous medium containing carbon and other impurities which are soluble in molybdenum under the formation of interstitial solid solutions. The Mo–Zr and Mo–Ti alloys investigated were melted in an electron-arc furnace, using cermet-grade molybdenum containing 0.01 weight % carbon and 0.005 weight % of each of oxygen and nitrogen, and iodide-type zirconium and titanium. The concentration of the second metal varied from 0.1 to 5 atomic % Zr and 10 atomic % Ti. The cast specimens were annealed at 1000 to 1400°C at a residual gas pressure of 1×10^{-2} to 1×10^{-3} and 1×10^{-4} torr. The study included examination of the microstructure before and after heat-treatment, x-ray spectroscopic and x-ray diffraction analysis, and determination of the crystal lattice constants. The results revealed that substituted solid solutions of titanium and zirconium in molybdenum are completely destroyed by heating in an atmosphere containing carbon and oxygen. After the destruction of these solid solutions, the crystal lattice constants were found to be much lower than those of unalloyed molybdenum. This indicates that the interstitial solid solutions in the molybdenum are destroyed at the same time, probably by activation near crystal imperfections caused by the removal of zirconium or titanium alloys. The selective removal of these metals is of potential industrial interest. (TTT)

46730 SNOEK RELAXATION PEAKS IN SOLID SOLUTIONS OF NIOBIUM. Ahmad, M. S.; Szkopiak, Z. C. (Univ. of Surrey, Eng.). J. Phys. Chem. Solids; 31: 1799–1804(Aug 1970).

A detailed study has been carried out of the broadening effect of Snoek peaks due to oxygen and nitrogen in niobium. It is shown that the broadening is due to the presence of subsidiary Snoek peaks caused by the stress-induced migration of interstitial atoms associated in pairs and triplets. It is suggested that the stress-induced migration of interstitial atoms associated in pairs and triplets involves single atoms only, while the other atoms remain in their original positions. The present results indicate that clusters containing more than three atoms do not cause relaxation peaks. (auth) (UK)

46731 ANELASTIC RELAXATION EFFECTS IN COLD-WORKED AND HYDROGEN-DOPED VANADIUM. Cannelli, G.; Mazzolai, F. M. (Consiglio Nazionale delle Ricerche, Rome). J. Phys. Chem. Solids; 31: 1913–19(Aug 1970).

The amplitude independent internal friction was measured in a series of vanadium-hydrogen alloys in the temperature range from 4.2 to 450°K, the vibration frequencies being included between 2×10^2 to 1×10^5 Hz. Experimental evidence was obtained of an inelastic effect occurring near 20°K in cold-worked pure vanadium; its activation energy and its frequency factor are 0.012 eV and 5×10^7 Hz, respectively. The introduction of hydrogen in the pre-strained material brings about a relaxation effect near 203°K, which is shown to be the hydrogen cold-work peak. A third relaxation effect, observed in prior annealed and then hydrogen-doped vanadium, appears to be a suitable means for studying the phase diagram of V–H system. (auth) (UK)

46732 TUGOPLAVKIE METALLY. (Refractory Metals). Polkhin, P. I. (ed.). Moscow; Izdatel'stvo Metallurgiya (1968). 132p.

Fifteen articles on the physicochemical properties of refractory metals (Mo, Nb, Re, Ta, Ti, and W) are presented. Metal ceramic methods for obtaining pure Re and W are discussed. Data are presented on the properties of B–C–W systems. (R.V.J.)

46733 STUDY OF MECHANICAL PROPERTIES OF NEW TITANIUM ALLOYS AT LOW TEMPERATURES. Koshelev, P. F.; Mikheev, V. S.; Nikitin, P. N. Probl. Prochnosti; No. 2, 40–5(Feb 1970). (In Russian).

Results of studies of the mechanical properties of binary, ternary, and multicomponent Ti alloys, especially suited for cryogenic technology, are presented. Descriptions are confined mainly to Ti alloyed with Ta. (tr-auth)

46734 THERMAL EXPANSION OF VANADIUM AND VANADIUM HYDRIDE AT LOW TEMPERATURES. Westlake, D. G.; Ockers, S. T. (Argonne National Lab., Ill.). J. Less-Common Metals; 22: 225–30(Oct 1970).

Interferometric dilatometry was used to determine the thermal coefficients of expansion for α-vanadium and β-vanadium hydride (31 at. % H) between –160 and 70°C. At the lower temperatures, the coefficients both approximated 6×10^{-6} per °C. At 70°C, the coefficient was 9×10^{-6} per °C for the metal, but was nearly double that value for the hydride. The expansions of both materials were expressed as fourth order polynomials by use of a computer program that minimized the root-mean-square error. The stress state in the vicinity of a hydride platelet embedded in a vanadium matrix cannot be predicted from the information presently available. (auth)

46735 E.M.F. MEASUREMENTS IN NIOBIUM–OXYGEN AND TANTALUM–OXYGEN SOLID SOLUTIONS. Fromm, E. (Max-Planck-Institut fuer Metallforschung, Stuttgart). J. Less-Common Metals; 22: 139–40(Sep 1970).

The validity of Henry's law for 0.2 to 2 at. % oxygen in Nb–O and Ta–O solid solutions at 1000°C was verified by emf measurements. (G.M.C.)

46736 TENSILE PLASTIC INSTABILITY AT AN ELEVATED TEMPERATURE AND ITS DEPENDENCE UPON STRAIN RATE. Wray, P. J. (United States Steel Corp., Monroeville, Pa.). J. Appl. Phys.; 41: 3347–52(Jul 1970).

Observations were made of the changes in shape that developed in initially cylindrical specimens of In–0.5% Pb and In–5.0% Pb alloys extended axially at overall strain rates in the range 1.2×10^{-7} to 1.7×10^{-4} sec^{-1} at a temperature of 0.69 T_m. To deal with the dynamic nature of neck formation and with the possibility that necks once formed may become dormant, the concept of neck activity is introduced. Two types of instability were observed. The first instability was related to the initiation of several active necks in a uniformly deforming specimen. It may occur at small strains (<0.05) and apparently is strain-rate sensitive. The second instability occurred at large strains and involved the unequal rate of growth of concurrently active necks, resulting in the final ascendancy of a single neck. The second instability was related to elevated temperature ductility. At high strain rates, where work hardening is dominant, it corresponds approximately to Considère's criterion, but at low strain rates, where viscous effects are significant, a postponement with respect to the Considère condition is observed, the ductility increasing with decreasing strain rate. (auth)

46737 CARBURIZATION OF TYPE 316L STAINLESS STEEL IN STATIC SODIUM. Litton, F. B.; Morris, A. E. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals; 22: 71–82 (Sep 1970).

The transport of carbon from an iron–87 wt % carbon alloy through static sodium to Type 316L stainless steel was investigated at temperatures of interest to the liquid-metal fast-breeder reactor (LMFBR) program. The rate-controlling step for the experimental geometry employed was the diffusion of carbon in the source. (auth)

46738 HARDNESS VARIATION WITH POLYCRYSTAL GRAIN SIZE OF NIOBIUM. Raghuram, A. C.; Armstrong, R. W. (Univ. of Maryland, College Park). J. Less-Common Metals; 22: 239–42(Oct 1970).

From a number of measurements on the grain-size dependence of the deformation properties of niobium material it was concluded that the polycrystal hardness data for niobium follow a Hall–Petch type of relation very well, but in this particular material the measured k_H value is probably lower than the true value due to the as yet unspecified nature of the dislocation substructure in these specimens. On the basis of the k_H measurement and single-crystal results, the value of k_Y determined by grain-size variation and, separately, stress–strain extrapolation for polycrystals are too small and too large, respectively; and these results are due also to the neglected influence of the dislocation substructure in these various cases. (auth)

46739 ROOM-TEMPERATURE ADSORPTION OF OXYGEN ON TUNGSTEN SURFACES: A REVIEW. Musket, R. G. (Sandia Labs., Livermore, Calif.). J. Less-Common Metals; 22: 175-91(Oct 1970).

Room-temperature adsorption of oxygen on tungsten surfaces is reviewed. Emphasis is on the adsorption features obtained from modern, experimental studies of polycrystalline and monocrystalline samples. Adsorption features discussed include coverage, sticking coefficient, adsorption states, work function change, and electron impact desorption cross sections. Possible reasons for disagreement on these adsorption features and some criteria for reproducible results are presented. (auth)

46740 SOLID SOLUTION INTRA-RARE-EARTH ALLOYS: REVIEW OF ALLOYING BEHAVIOR AND STRUCTURE. Koch, C. C. (Oak Ridge National Lab., Tenn.). J. Less-Common Metals; 22: 149-73(Oct 1970).

A review of the alloying behavior of intra-rare-earth alloys is presented. Intra-rare-earth binary alloy systems may be divided into three groups: alloy systems which exhibit complete solid solubility; alloy systems which exhibit phase separation at lower temperatures; and alloy systems which follow the same sequence of close-packed phases across their binary phase diagrams as is found across the lanthanide series in the Periodic Table of the elements. This review concentrates on the third class of binary systems. The experimental work on these alloys is discussed and the several proposed explanations for the stacking sequences of close-packed planes across the lanthanide series and in the intra-rare-earth alloys are reviewed. (auth)

Structure and Phase Studies

Refer also to abstract 46799.

46741 INDEXING ELECTRON DIFFRACTION PATTERNS FOR HEXAGONAL ZIRCONIUM ALLOYS. Bedford, A. J. (Univ. of Adelaide). J. Less-Common Metals; 22: 141-8(Sep 1970).

Corrections for a recent paper on Zr standard crystal electron diffraction patterns by Chaturvedi and Singh [J. Less-Common Metals 18: 71(1969)] are presented. Twenty-four consistently-indexed diffraction patterns are presented which correspond to those presented by the cited authors to correct and make the diffraction patterns more usable. (J.R.D.)

46742 EVIDENCE FOR 4f CONTRIBUTION TO THE BONDING IN SOME CUBIC RARE-EARTH COMPOUNDS. Burzo, E. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 611-13 (1970).

The $R.E.T_2$ intermetallic compounds (where R.E. = rare earth and T = Fe, Co, or Ni) present a cubic (C15) Lave Phase structure of $MgCu_2$-type, the spatial group being Fd3m. The elementary cell contains 8 rare earth atoms and 16 transition metal atoms, the latter being disposed inside the cell in the corner of some tetrahedra. A difference exists between the dimensions of the two atoms, the rare earth having the greater atomic radius. In the most compact arrangement of atoms, the rare-earth-to-rare earth contacts have greater radii than do the rare-earth-to-transition metal contacts. This implies participation of 4f electrons in rare-earth-to-rare-earth contacts. Data and evidence are presented to support this hypothesis. (J.R.D.)

46743 SYSTEM GALLIUM-INDIUM-TIN. van Ingen, G. N.; Kapteijn, J.; Meijering, J. L. (Technical Univ., Delft, Netherlands). Scr. Met.; 4: 733-6(Sep 1970).

Phase equilibria in the system were determined by thermal and x-ray analysis. Results of thermal analysis showed a ternary eutectic temperature of 10.7°C. Other data and information on reactions and phases as affected by composition and temperature are included. (J.R.D.)

46744 INTERACTION OF SLIP DISLOCATIONS WITH TWIN BOUNDARIES. Vallance, D. M.; Bevis, M. (Univ. of Liverpool). Scr. Met.; 4: 681-4(Sep 1970).

Mechanisms of resolved shear stress on matrix and twin slip systems in the operation of slip-twin interactions are examined. Results of Schmidt's factor calculations are included which were used in the design of experiments directed toward study of slip-twin interactions. (J.R.D.)

46745 OBSERVATIONS ON THE LATTICE SPACINGS OF SOME αPd-X SOLID SOLUTIONS AND SOME Pd_3X PHASES. Harris, I. R. (Birmingham Univ., Eng.); Norman, M. J. Less-Common Metals; 22: 127-30(Sep 1970).

Results of analyses are presented which indicate that a substantial proportion of α-Pd lattice expansion by solute atoms can be attributed to filling the 4d-states by solute valency electrons. The more open nature of the lattices in these alloys compared with normal substitutional solid solutions should have an important bearing on the rate of H diffusion through the α-Pd-X lattice. (J.R.D.)

46746 INELASTIC AND QUASI-ELASTIC SCATTERING OF SUBTHERMAL NEUTRONS IN ThH AND NbH. Rubin, R.; Claessen, Y. (EURATOM-CCR, Ispra, Italy). Solid State Commun.; 8: 1321-4(15 Aug 1970).

The inelastic neutron scattering spectra of ThH (5% atomic) at 30°C and 200°C were measured. A local mode was observed, but no band modes could be detected at E = (114 ± 5) MeV, similar to the case of PdH, both host lattices having fcc symmetry. By measurements of the broadening of the quasi-elastic spectrum of NbH (7% atomic) in the temperature range between 100°C and 250°C at two different values of momentum transfer $\vec{K}$, an activation energy E_α = (90 ± 10) MeV was determined. (auth) (UK)

46747 KNOWLEDGE OF THE MAGNESIUM-EUROPIUM SYSTEM. IV. THE CRYSTAL STRUCTURE OF Mg_5Eu. Muehlpfordt, Werner (Westfaelische Wilhelms-Univ., Muenster, Ger.). Z. Anorg. Allg. Chem.; 374: 174-85(May 1970). (In German).

The crystal structure of Mg_5Eu was determined. Its space group is $P6_3/mmc-D^4_{6h}$, with unit cell dimensions a = 10.41$_2$, c = 10.76$_2$ Å; 6 formula units per unit cell. The Eu atoms form triangles similar to the Sr atoms in Mg_4Sr. (auth)

46748 PHASE DIAGRAM OF THE NIOBIUM-ZIRCONIUM-VANADIUM SYSTEM. Dzhienbekova, A. A.; Budberg, P. B.; Asanov, U. A. Izv. Akad. Nauk Kirg. SSR; No. 1, 39-42(Jan 1970). (In Russian).

Observations of microstructure along with x-ray analyses and the drop method were used for constructing the solidus curve of the Zr-V-Nb system and the isothermal cross sections at 1200, 1000, 800, and 600°C. A ternary compound of $Zr(V_{1.33},Nb_{0.33})$ was discovered and the formation and homogeneous solid solution region was found on the basis of the ternary compound. (tr-auth) (INIS)

46749 ENTHALPIES OF MELTING OF III/V, IV/V, AND V/VI COMPOUNDS. Blachnik, R.; Schneider, A. (Technische Univ., Clausthal, Ger.). Z. Anorg. Allg. Chem.; 372: 314-24 (Feb 1970). (In German).

The enthalpies of melting of GaSb, InSb, InBi, Bi_2Tl, SnAs, GeAs, $GeAs_2$, Be_2Se_3, Sb_2Se_3, As_2Te_3 and As_2Se_3 were determined in a drop-calorimeter. The experimental values lead to the conclusion that by their behavior on melting three types of melting in these compounds can be defined,including transition of an ordered crystal with covalent bonds to a metallic melt with statistical distribution of atoms; transition of a crystal with layer or chain structure to a melt with molecule formation and a high degree of short-range order, and transition of an ordered metal-crystal to a melt with metallic character and statistical distribution of atoms. These types were confirmed by the different dependence of the enthalpy of melting from the width of the forbidden gap. (auth)

46750 ROLLING AND RECRYSTALLIZATION OF BERYLLIUM SINGLE CRYSTALS. Hulsey, William Jewell. Knoxville, Tenn.; Univ. of Tennessee (1969). 265p. University Microfilms Order No. 70-7575.

Thesis.

The mechanisms of texture development and the relationships between deformation modes and recrystallization behavior in beryllium were investigated. Beryllium single crystals with six different initial orientations were rolled at 500°C. X-ray measurements of the deformation textures were correlated with polarized light measurements of metallographic samples to examine the deformation modes and identify the deformation features of the microstructures. The largest reorientation effects were produced by $\{10\bar{1}2\}$ twinning. This mechanism moved basal poles from the rolling direction to a lesser extent from the transverse direction to the vicinity of the rolling plane normal. A relatively stable end orientation was found with basal poles forty degrees from the rolling plane normal toward the transverse direction. This is thought to result from duplex $\{10\bar{1}X\}\langle 11\bar{2}0\rangle$ slip, the $\{10\bar{1}X\}$ plane resulting from cross-slip between the (0002) and $\{10\bar{1}0\}$ planes. Two new microstructural effects were noted in crystals oriented for compression along the c axis. These were interpreted as two forms of deformation banding resulting from slip with a nonbasal Burgers vector. These bands played an important role in both the deformation and recrystallization behavior. Annealing the crystals at 700 and 800°C resulted in a recrystallization ranging from 0 to 53 percent and 8 to 98 percent, respectively. The stable end or orientation as an initial orientation experienced the least recrystallization. Extensive twinning produced the largest percent recrystallization. Recrystallization by subgrain growth and from "preformed nuclei" was observed. These

preformed nuclei were primarily fragments of $\{10\bar{1}2\}$ twins. (Diss. Abstr. Int., B)

46751 POLYMORPHIC TRANSFORMATION IN YTTERBIUM. Kayser, F. X. (Ames Lab., Iowa). Phys. Rev. Lett.; 25: 662-4 (7 Sep 1970).

The discovery of a polymorphic transformation in Yb is reported and its significance in relation to recent high-pressure studies is discussed. The transformation, β(fcc) $\longleftrightarrow$ α(hcp), is martensitic, the α phase being the stable form at 1 atm below ~270°K. The slope of the α/β equilibrium boundary, $(dT_{\alpha\beta}/dP)_{270°,\ 1\ atm}$, is (-23 ± 8)°K/kbar. (auth)

46752 NEUTRON-DIFFRACTION INVESTIGATION OF ZIRCONIUM NITRIDE-HYDRIDE. Bykov, V. N.; Golovkin, V. S.; Levdik, V. A.; Kalinin, V. P.; Miron, N. F. Sov. Phys.-Cryst. (Engl. Transl.); 15: 317(Sep-Oct 1970).
Translated from Kristallografiya; 15: 376(Mar-Apr 1970).

$ZrN_{0.36}H_{0.80}$ was studied with 0.90-Å neutrons in order to locate the N and H atoms. The neutron reflections were indexed well within the x-ray cell with a = 3.274 and c = 5.529 Å. A number of superstructural reflections indicated ordering of nonmetallic atoms and deviation of the Zr atoms from the ideal hexagonal dense packing. The N atoms occupy octahedra through layers by increasing the distance between metallic atoms, while the H atoms are arranged throughout the entire tetrahedra, but in the layer occupied by N there are four times fewer H atoms than in the free layer. (D.L.C.)

46753 TRANSMISSION ELECTRON MICROSCOPIC OBSERVATION OF THE TRANSITION PHASE OMEGA IN Ti-Mo AND Ti-Mn ALLOYS. Ikawa, Hiroshi (Osaka Univ.); Shin, Shigeo; Miyagi, Masakazu; Morikawa, Masaki. J. Jap. Inst. Metals; 34: 673-9(Jul 1970). (In Japanese).

The transition phase, ω, which is formed during the transformation $\beta/\beta + \alpha$, makes the alloys very hard and brittle. This ω phase was investigated by transmission electron microscopy in the Ti-Mo (β isomorphous type) and the Ti-Mn (β eutectoid type) system. The ω phase in Ti-Mo alloys was ellipsoidal with a major axis parallel to $\langle 111\rangle_\beta$, its maximum size being about 2000 Å. On the other hand, the shape of the ω phase in Ti-Mn alloys was cubic with a habit plane $\{100\}_\beta$, its maximum size being about 300 to 350 Å. The ω phase in the quenched material (ω') of Ti-Mo alloys formed more easily with the decrease of solute atom content and extended in the form of a very fine needle parallel to $\langle 111\rangle_\beta$. (auth) (Japan)

46754 CRYSTAL STRUCTURE OF Eu_5Pb_3. Franceschi, E. (Univ., Genoa). J. Less-Common Metals; 22: 249-52(Oct 1970).

The crystal structure of Eu_5Pb_3 was determined by the powder method, using FeKα and CrKα radiations. (G.M.C.)

46755 SUPERCONDUCTIVITY AND LATTICE PARAMETERS OF THE DIRHENIDES AND DITECHNIDES OF THORIUM, HAFNIUM, AND ZIRCONIUM. Giorgi, A. L.; Szklarz, E. G. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals; 22: 246-8(Oct 1970).

The dirhenides and ditechnides of thorium, hafnium and zirconium crystallizing in the hexagonal C-14 Laves structure were prepared from the elements. They were all found to be superconducting with transition temperatures, T_c, ranging from 5.0 to 7.6°K. (auth)

46756 GROWTH OF TUNGSTEN SINGLE CRYSTALS FROM THE GAS PHASE BY CHEMICAL REACTIONS. Weise, G.; Owsian, G. (Institutsteil fuer Metallphysik und Reinstmetalle, Dresden). J. Less-Common Metals; 22: 99-116(Sep 1970). (In German).

Tungsten single crystals with $\langle 110\rangle$-, $\langle 100\rangle$-, and $\langle 111\rangle$-orientation of the rod axis were prepared by thermal dissociation of tungsten hexachloride. The morphology of single crystals was observed by optical and electron microscopy and the real structure was investigated by metallographic and x-ray examinations. The single crystals showed $\{110\}$, $\{100\}$, $\{211\}$, and $\{111\}$ alone or in combination as boundary faces. Under the conditions of growth used, the equilibrium faces were preponderantly $\{110\}$ in form, while other faces were coarse grained by overgrowth of small $\{110\}$ units. The stepped surface structure led to the formation of disturbed layers as cracks or substructures in the body of the crystal. This was a consequence of the supersaturation inhomogeneities on the crystal surface. The growth over macroscopically smooth boundary faces by relatively high supersaturation, yielded homogenous (free of disturbed layers) tungsten single crystals, obtained with $\langle 111\rangle$-orientation of the rod axis and with $\{110\}$ as boundary face. (auth)

Radiation Effects

Refer also to abstracts 47306 and 47319.

46757 USE OF CHARGED PARTICLE ACCELERATORS FOR INVESTIGATING MATERIALS PROBLEMS OF NUCLEAR REACTORS. Pugh, S. F. (Atomic Energy Research Establishment, Harwell, Eng.). J. Brit. Nucl. Energy Soc.; 9: 189-206 (Jul 1970).

The use of beams of charged particles from accelerators to investigate radiation damage phenomena is reviewed. Rates of atomic displacement and electron excitation effected in typical charged particle irradiation experiments are two or three orders higher than damage rates which will be obtained in projected fast reactors in the next decade. Therefore, using ion beams for simulating the effects of 30 year life doses in fast reactors, the required damage intensities can be reached in a reasonable time. Charged particle irradiation is also useful for investigating damage mechanisms, and in providing a technique for investigating basic collision theory. These advantages and the disadvantages in using ion beams are discussed in detail in relation to each of the main reactor radiation damage phenomena. Electron excitation, atomic displacement and transmutation which can all be produced or simulated by charged particle irradiation, are discussed. Electron excitation effects caused by Compton electrons and primary knocked-on atoms cause radiolysis and changes in the chemical reactivity of the coolant, and hence also changes in corrosion rates of materials exposed to the coolant. Atomic displacement processes are responsible for the growth of α-uranium, void formation in structural materials in the core and rise in the brittle-ductile transition temperature in pressure vessel steels. Accumulation of transmutation products is simulated by implantation of the atomic species of a beam of charged particles into specimens of thickness greater than the range of the bombarding ion. The main reactor interest is in the implantation of the inert gases He, Xn and Kr which are responsible for high temperature embrittlement of structural materials and swelling of fuel. (auth) (UK)

46758 RADIATION EFFECTS IN STRUCTURAL MATERIALS. Kangilaski, M. Reactor Mater.; 13: 124-31(1970).

Results of research are summarized on radiation testing of stainless steels, Ni alloys, pressure vessel steels, Inconel, and Ta alloys. Findings in research on basic mechanisms of radiation damage in nonfuel materials are also summarized. (J.R.D.)

46759 HELIUM PRODUCTION IN EBR-II IRRADIATED STAINLESS STEEL. Dudey, N. D. (Argonne National Lab., Ill.); Harkness, S. D.; Farrar IV, H. Nucl. Appl. Technol.; 9: 700-10(Nov 1970).

Helium concentrations have been measured in sections of Type 304 stainless steel control and safety rod thimbles irradiated in EBR-II to a peak fluence of 8.8×10^{22} n/cm^2. The results, obtained by high-sensitivity gas mass spectrometric techniques, show that more helium is produced than is predicted on the basis of calculations, especially at the higher temperature regions of the rods. It is concluded that sources of helium by the (n,α) process with elements other than the primary constituents of stainless steel contribute a significant fraction of the total helium produced and that one or more of these impurities might be migrating to the hotter surfaces of the stainless steel. A 45% gradient of nitrogen concentration along one rod was measured but that alone seems insufficient in magnitude to explain the helium gradient. (auth)

46760 INCOLOY 800: ENHANCED RESISTANCE TO RADIATION DAMAGE. Harman, D. G. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 561-71(Oct 1970).

Tensile and creep-rupture data have been obtained at 700 and 760°C for several experimental heats of Incoloy 800 that were irradiated in the Oak Ridge Research Reactor (ORR) at elevated temperatures or held at control temperatures in the laboratory. Effects of composition, grain size, and stress level (or strain rate) on these strength properties were investigated. Enhanced postirradiation ductility was observed in Incoloy 800 containing ~0.1% Ti in creep-rupture tests. The maximum ductility for this composition was obtained in fine-grained specimens tested at low creep stress levels, and the ductility appeared to be unaffected by carbon content. The ductility of unirradiated material was also increased by decreasing either grain size or strain rate. Significant variations in properties (both control and postirradiation tests) were noted for alloys within the commercial Incoloy 800 specification range. The ductility peak at ~0.1% Ti is not fully understood; it might be best explained by two independent mechanisms, one accounting for the increasing ductility with increasing titanium at levels less than 0.1% and the other explaining the decreasing ductility at higher titanium levels. The

grain size effect may be due to differences in the distribution of helium and/or trace elements or to a grain-size dependent variation in stresses necessary for grain boundary fracture. Higher postirradiation ductility at lower stresses could be due to stress relaxation, grain boundary migration, or less pronounced stress-induced growth of helium bubbles present in the grain boundaries. (auth)

46761 EFFECT OF IRRADIATION ON THE ELEVATED TEMPERATURE FRACTURE OF SELECTED FACE-CENTERED CUBIC ALLOYS. Kangilaski, M.; Peterson, S. L.; Perrin, J. S.; Wullaert, R. A. (Battelle Memorial Inst., Columbus, Ohio). Nucl. Appl. Technol.; 9: 550-60(Oct 1970).

Various alloys with face centered cubic structures were irradiated to fast fluences of 1.5×10^{21} n/cm^2 (E > 1 MeV) and tested in tension at elevated temperatures. The alloys which were investigated included pure nickel (99.999%), Nickel 200, a non-nickel manganese stabilized stainless steel (Tenelon) and two cobalt alloys. One of the cobalt alloys contained 10% nickel (Haynes Stellite-25) while the other was nickel free (UMCo-50). It was found that irradiation caused embrittlement in all of these alloys when they were tested in tension at elevated temperatures. (auth)

46762 DUCTILITY LOSS IN FAST REACTOR IRRADIATED STAINLESS STEEL. Ward, A. L.; Holmes, J. J. (Battelle-Northwest, Richland, Wash.). Nucl. Appl. Technol.; 9: 771-2 (Nov 1970).

Results from a postirradiation annealing study show that ductility losses in austenitic stainless steels result from a combination of helium embrittlement and displacement damage at temperatures above $T_m/2$. Residual losses following removal of the displacement damage by annealing at ~0.8 T_m are attributed to helium embrittlement alone. (auth)

Ceramics and Cermets

Refer also to abstracts 46692 and 46693.

46763 (UCRL-19155) INORGANIC MATERIALS RESEARCH DIVISION. Annual Report, 1969. (California Univ., Berkeley. Lawrence Radiation Lab.). May 1970. Contract W-7405-eng-48. 263p. Dep. CFSTI.

Progress is reported in chemistry, metallurgy, ceramic science, and solid-state physics. (D.H.M.)

Corrosion and Erosion

46764 HIGH-TEMPERATURE TORSION–EFFUSION STUDY OF THE INTERACTION OF METAL OXIDES WITH GRAPHITE AND WITH METAL CARBIDES. Rai, Juey Hong. Seattle; Univ. of Washington (1969). 214p. University Microfilms Order No. 70-8490.

Thesis.

In the usual method, equilibrium pressures are derived from effusion experiments by extrapolation of steady-state pressures, measured as a function of orifice area, to zero orifice area. For a reaction between solid phases (in which a gas is formed), such an extrapolation method may not be feasible because the rate of the reaction may not be sufficiently rapid to maintain constant steady state effusion pressures. Effusion pressures of Ca(g) and CO(g), generated by reaction of CaO(s) with graphite in temperature range 1420 to 1520°K and by CaO with ZrC in temperature range 1500 to 1600°K, respectively, were measured as a function of time by the torsion method. For the CaO–graphite reaction, pressures were found to decrease in a manner such that log P vs. t exhibited a linear relationship. This relationship provided a suitable form for extrapolation of effusion pressures back to time zero to derive predicted equilibrium constants for the reaction. The results and associated thermodynamic properties are in good agreement with those predicted from independent works of others. The catalytic effect of CaF_2(s) on the reaction of CaO(s) with graphite has also been studied. The equilibrium constants derived from the two independent studies (with and without CaF_2) are in good agreement. Evidence has been found to suggest that the reaction between zirconium carbide and calcium oxide proceeds according to the equation $ZrC(s) + 4CaO(s) = CaZrO_3(s) + 3Ca(g) + CO(g)$. Steady state effusion pressures decrease with time in a manner expected if it is assumed that the rate of production of vapor is controlled by diffusion of reactants through the product layer. Two zirconium carbide samples of slightly different stoichiometry were used. Thermodynamic properties of these phases have been derived from effusion data and compared with results of independent studies. Knudsen effusion experiments were also carried out. The production of calcium vapor by these reactions was confirmed and the magnitude of the partial pressures of calcium in the Knudsen effusion experiment was found to be generally consistent with the torsion experiments. (Diss. Abstr. Int., B)

Preparation and Fabrication

Refer also to abstracts 46302, 46411, 47865, and 47991.

46765 (BMI-1831) MIDYEAR REPORT ON DEVELOPMENT PROGRAM FOR FABRICATION OF COMPOSITE FUEL FORM OF $^{238}PuO_2$. Pobereskin, Meyer (Battelle Memorial Inst., Columbus, Ohio). 11 Mar 1968. Contract W-7405-eng-92. 100p. Dep. CFSTI.

A program was initiated to develop a process for fabrication of a composite $^{238}PuO_2$ fuel form for operation at 1500°C. Thermodynamic analyses and preliminary compatibility experiments led to the selection of molybdenum and magnesium oxide as the most suitable metal and ceramic matrix materials for evaluation. Graphite die designs were developed for the uniaxial hot pressing of spherical, annular, and disk specimens. Fabrication studies resulted in the selection of a densification process based upon PuO_2 particles coated by chemical vapor deposition with the matrix material. The coating processes for both molybdenum and MgO coatings on spherical PuO_2 particles were developed. Processing parameters for fully dense composites with molybdenum matrix were established and three evaluation specimens, one of each geometry, were fabricated. Microsphere swelling was observed at 1800°C; measures are being studied to correct this condition. (auth)

46766 (BMI-1849) SUMMARY REPORT ON DEVELOPMENT PROGRAM FOR FABRICATION OF COMPOSITE FUEL FORM OF $^{238}PuO_2$. Pardue, W. M.; Smith, R. A.; Houston, M. D.; Lozier, D. E.; Browning, M. F.; Pobereskin, M. (Battelle Memorial Inst., Columbus, Ohio). 16 Sep 1968. Contract W-7405-eng-92. 130p. Dep. CFSTI.

The program to develop a process for fabrication of a composite $^{238}PuO_2$ fuel form for operation at 1500°C was continued. Mechanical properties of the composite fuel form measured at 1000 to 1500°C indicate an outstanding impact resistance such as would enhance fuel retention after reentry. The thermal conductivity of the fuel form is sufficient to permit relatively low centerline operating temperatures in energy conversion devices. This fuel form has an inherent power density of 4.1 W per cm^3. Experiments at 1500°C for 1500 hr on composite fuel form specimens of molybdenum matrix materials showed little or no evidence of reaction and excellent dimensional stability. No dimensional or significant structural changes were detected upon examination of molybdenum matrix composites after heat treatments to 2100°C simulating thermal-cycling conditions in the event of reentry. Magnesia matrix composites given similar treatments to 1800 or 1900°C withstood the tests in excellent physical condition. Molybdenum matrix composites made with hydrogen-treated fuel particles showed no interaction after 1 hr at 2350°C; with untreated fuel particles, the original details of the composite were maintained for a short time at a maximum temperature in the range 2150 to 2200°C. Sol-Gel $^{239}PuO_2$ microspheres were used as the stand-in fuel for the study. Generation of porosity in, and swelling of, this material upon heating above 1300°C was eliminated by a pretreatment with hydrogen at 1400°C. Molybdenum and MgO were selected, on the basis of chemical compatibility with PuO_2, as matrix materials for the fabrication process development. Graphite die designs were established for the uniaxial hot pressing of 1-in.-diameter spherical, annular, and disk specimens. The densification process developed consisted of hot compaction of PuO_2 particles coated by chemical vapor deposition with the matrix material. Except for the annular geometry with a ceramic matrix, 1-in.-diameter specimens of the above three geometries were successfully fabricated of both high and low density, 93 and 80 percent of theoretical, respectively. These specimens exhibited controlled and reproducible composite density, reproducible uniform fuel dispersion, and a continuous and uniform matrix web surrounding the fuel particles. Exposed fuel particles on the surface of the as-pressed specimens were readily and uniformly coated with tungsten by chemical vapor deposition. Because of the high fuel loading (80 vol %), the particles were distorted in shape, but retained their chemical integrity except for a slight reduction in O:Pu ratio. Because of the superior characteristics measured for the molybdenum matrix composite, compared to the magnesia matrix composite, the former was recommended for further study and development. A single, 1-in.-dia disk with molybdenum matrix and plasma-torch $^{238}PuO_2$ fuel particles was readily fabricated by the process developed using $^{239}PuO_2$ Sol-Gel microspheres. (auth)

46767 (BMI-1860) MID YEAR REPORT FOR THE PROGRAM TO DEVELOP COMPOSITE FUEL FORMS OF $^{238}PuO_2$. Pardue, W. M.; Smith, R. A.; Houston, M. D.; Lozier, D. E.; Browning, M. F.; Thompson, J. R. Jr.; Bauer, A. A.; Pobereskin, M. (Battelle Memorial Inst., Columbus, Ohio). Mar 1969. Contract W-7405-eng-92. 76p. Dep. CFSTI.

Development of the $^{238}PuO_2$ composite fuel form continued with emphasis upon increasing its inherent capability to contain the ^{239}Pu. Two approaches were taken toward this goal: development of a continuous, oxidation-resistant coating for the PuO_2–molybdenum cermet fuel form and development of an advanced composite structure based upon the densification and compaction of duplex-coated particles. In simulated reentry tests in a plasma-arc tunnel, $^{238}PuO_2$–molybdenum cermet specimens coated with an inner layer of molybdenum and an outer layer of tungsten (~10 mils total thickness) lost about 2 to 10 percent of the composite fuel form depending upon heat flux conditions. It was estimated that front face temperatures ranged from 2350 to 2750°C. The structure of the cermet just one particle layer behind the ablated front face was essentially unaffected. With UO_2–molybdenum cermets used as a stand-in material for the PuO_2–molybdenum cermets, specimens coated with ThO_2 over molybdenum or tungsten (~10 mils total thickness) experienced little or no loss of the composite material in similar arc-tunnel tests, although some sections of the ThO_2 coating on the front edge flaked off. Impact tests were performed on tungsten-over-molybdenum-coated $^{238}PuO_2$-molybdenum cermet specimens 1 in. in diameter by ½ in. thick. One specimen, impacted at 125 fps, broke into six major chunks and some debris. Only about 0.2 percent of the total specimen weight was in particles less than 53 μ in diameter. Advanced composite fuel form specimens were fabricated based on duplex-coated $^{238}PuO_2$ particles; i.e., ThO_2 over molybdenum coatings, and molybdenum over ThO_2 coatings. Sound structures of 90 to 95 percent of theoretical density, with homogeneous distribution of the fuel particles and a uniform and continuous matrix, were fabricated for both types of materials and at both 65 and 80 vol % fuel loadings. Specimens of both types of advanced composite materials, and each fuel loading, were tested in the arc tunnel under the conditions described above. Only about 2 percent of the composite was lost, with behavior being markedly similar for all specimens tested. Behind the apparently thin molten layer on the front face, the original cermet structure retained its integrity. (auth)

46768 (BMI-1869) FINAL REPORT FOR THE PROGRAM TO DEVELOP COMPOSITE FUEL FORMS OF $^{238}PuO_2$. Pardue, W. M.; Smith, R. A.; Houston, M. D.; Lozier, D. E.; Browning, M. F.; Thompson, J. R. Jr.; Bauer, A. A.; Pobereskin, M. (Battelle Memorial Inst., Columbus, Ohio). Sep 1969. Contract W-7405-eng-92. 133p. Dep. CFSTI.

Parameters were established for fabricating cermets incorporating production-grade plasma-torch $^{238}PuO_2$ microspheres. Hot pressing of molybdenum-coated $^{238}PuO_2$ particles at 1550°C for 5 min under 12,000 psi yielded fully dense specimens of the reference fuel form ($^{238}PuO_2$–19 vol % molybdenum). Equipment and processes were developed for depositing the reference duplex coating (nominally 2 mils of molybdenum overcoated with about 4 mils of thoria) on full-size cylindrical and annular cermet specimens. Seven reference-fuel-form rings, each about 1.35 in. OD by 0.60 in. ID by 0.5 in. thick before being coated with thoria over molybdenum, were fabricated as a 200-W (thermal) loading for the Isotope Brayton Heat Source Capsule. The reference fuel form remained stable at temperatures to 1500°C for times to 250 hr in dynamic vacuum. Stability was maintained upon subsequent heating for 1 hr at 550°C in helium and quenching in water. The reference fuel form reacted in air at 1000°C. Coated and uncoated specimens subjected to a thermal spike showed excellent resistance to thermal shock. Reference fuel forms held at 1500°C for 2600 hr expanded, lost weight, developed bubbles, and showed matrix separation. However, results for similar specimens maintained at lower temperatures indicated that a 5-yr life can be predicted for fuel operating at about 1000°C. Helium release data indicated that coated or uncoated reference fuel forms will release most of their helium inventory over the long term of expected application at elevated temperatures. The solubility of helium in both $^{239}PuO_2$ and $^{238}PuO_2$ was determined to be 5×10^{-4} cm³ per g-atom at 1000°C. The diffusion coefficient of helium in PuO_2 was estimated as about 6.2×10^{-14} cm² per sec at this temperature. (auth)

46769 (BNWL-1445) INVESTIGATION OF MIXED OXIDE $(U_{0.72}Pu_{0.28})O_2$ PROCESSING USING A NINE VARIABLE FRACTIONAL FACTORIAL EXPERIMENT. Barr, M. J.; Jaech, J. L.; Anderson, A. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. Contract AT(45-1)-1830. 73p. Dep. CFSTI.

A process development program was undertaken to support production of high quality mixed oxide (25% PuO_2–75% UO_2) fast reactor fuel pellets. In addition to an evaluation of variables associated with each unit operation, a fractional factorial experiment was designed to show variable effects and interactions that occur in the process as a whole. The experiment discussed involves nine key process variables including: calcination temperature of PuO_2, preslugging pressure, pressing pressure, binder type, binder percentage, percent addition of sintered recycle powder, particle size of sintered recycle powder, sintering time, and sintering temperature. The measured dependent variables were green density, sintered density, sorbed gas, percent shrinkage and uniformity of diameter and sintered density. (auth)

46770 (DP-Report-153) EVALUATION STUDIES OF COATED PARTICLE FUEL WITHIN THE PROJECT. Project DRAGON. Vivante, C.; Hauser, G.; Nybo, S. (Atomic Energy Establishment, Winfrith (England)). Jan 1963. 29p. (CONF-630103-26). Dep. CFSTI.

From Fuel Element Symposium, Bournemouth, Eng.

Research is described on the various Dragon fuel test methods and their evaluation. It is noted that though preirradiation tests are helpful, they cannot be considered among the selective criteria until after the long term stability and burnup behavior of the fuel particles are established. (J.R.D.)

46771 (NP-18432) PRESS SINTERED HEXABORIDE CATHODES. Final Report. Wolski, W. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). 24 May 1969. 30p. Dep. CFSTI (U. S. Sales Only).

The fabrication and properties of press sintered lanthanum, yttrium, and gadolinium hexaboride cathodes under operating conditions were studied. The conditions were similar to those which cathodes meet in microtron accelerators. Experimental results for saturated emission and the dependence of pulse current on the cathode temperature are given. (Sweden)

46772 (NYO-4142-1) IMPROVED SUBSTRATES FOR ELECTRON MICROSCOPY. Progress Report, September 1, 1969–August 31, 1970. Beer, Michael (Johns Hopkins Univ., Baltimore, Md. Dept. of Biophysics). Contract AT(30-1)-4142. 11p. Dep. CFSTI.

Research on graphitization of thin carbon films is summarized. Work on preparation of grids is described along with heat treatment procedures. The crystallinity of treated films is described and the quality of the films evaluated. Specimen preparation using graphite support films is reported. It was concluded that carbon films suitable for electron microscopy can be converted to graphitic films by heat treatment. (J.R.D.)

46773 (WARD-4135-8) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending March 31, 1970. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). Jul 1970. Contract AT(30-1)-4135. 159p. Dep. CFSTI.

Research results are summarized on fuel performance analytical methods, development of codes for performance of mixed oxide fuel rods, mixed oxide fuel pin irradiation, mixed oxide grid assembly irradiation, fuel pin design, fabrication of EBR-II fuel assemblies, subassembly design, pellet fabrication, fuel characterization, quality control, and fuel assembly fabrication. (J.R.D.)

46774 METHOD FOR THE PREPARATION OF URANIUM DIOXIDE POWDER (UO_2) WITH GOOD PRESSING AND SINTERING PROPERTIES FROM URANIUM HEXAFLUORIDE (UF_6) OR AQUEOUS SOLUTIONS OF URANYL NITRATE [$UO_2(NO_3)_2$]. Vietzke, Horst; Ploger, Fritz; Wegner, Klaus; Pirk, Hans (to Nukem Nuklear-Chemie und -Metallurgie GmbH). U. S. Patent 3,519,403. 7 Jul 1970. Priority date 17 Dec 1966, Germany.

Uranium dioxide of good pressing and sintering behavior is prepared by precipitating ammonium uranyl carbonate by continuously introducing as gases UF_6, NH_3, and CO_2 into an ammonium carbonate solution with a constant pH of 7.8 to 8.6. The ammonium uranyl carbonate is spontaneously decomposed and gas reduced in a furnace to obtain a pure uranium dioxide powder. The reduction is preferably carried out in a fluidized bed at 500 to 600°C using a mixture of hydrogen and water vapor. (auth)

46775 RATE CONTROLLING FACTORS IN THE CARBOTHERMIC SYNTHESIS OF ADVANCED FUELS. Lindemer, T. B. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.: 9: 711-15(Nov 1970).

Considerable effort has been expended to synthesize the carbides, nitrides, and carbonitrides of uranium, plutonium, and their solid solutions by the carbothermic reduction of oxide-carbon mixtures. Experimental results reported in the litera-

ture for the U–C–O–N system indicate that one of two limiting mechanisms control the rate of the conversion reaction. These mechanisms are solid-state diffusion within the individual reactant-product particles and removal of CO from the entire reacting system. This reported information is used to analyze the use of a fluidized bed for carbothermic conversion in the vicinity of 1500°C in the U–C–O–N system and to approximate the rate of conversion in the U–Pu–C–O–N system. (auth)

46776 COMPOSITE REFRACTORY STRUCTURE. Gordon, Emanuel (to United Nuclear Corp.). U. S. Patent 3,519,405. 7 Jul 1970. Filed 1 Feb 1966.

A composite light refractory structure is formed by diffusion bonding particles with a core of alumina or beryllia and a thin surface coating of tungsten. The volume fraction of the tungsten coating is less than about 0.20, and the density of the refractory structure is above 58% of the theoretical density. (auth)

46777 SIMPLE TECHNIQUE FOR SEALING METALS TO STABILIZED ZIRCONIA BY MEANS OF GLASS SEALS. Pizzini, S.; Bonomi, A.; Colombo, P. (Univ., Milan). J. Phys., E (London); 3: 832(Oct 1970).

A simple technique for sealing stabilized zirconia tubing was devised, which gives excellent mechanical and gas tightness properties. The seal is formed by bonding a suitable nickel-iron alloy with zirconia by means of a soft glass layer. (auth) (UK)

46778 KINETICS OF PREPARATION OF DYSPROSIUM BORATE AND OF A PART OF THE LIQUIDUS PHASE DIAGRAM DYSPROSIUM BORATE–DYSPROSIUM OXIDE. Sheikh, P. A. (Atomic Energy Commission, Karachi, Pakistan); Winand, R.; Flipot, A. J. J. Less-Common Metals; 22: 231-8(Oct 1970).

The kinetics of the preparation of dysprosium borate ($DyBO_3$) by sintering various mixtures of dysprosium oxide and boron oxide, employing sintering durations of ¼ to 6 hr and temperatures between 600 and 1400°C were determined by x-ray diffraction studies. The reaction curves between dysprosium oxide and boron oxide are plotted. The thermal stability of dysprosium borate was determined by resintering for 12 hr at 1400°C. The melting point of dysprosium borate was found to be 1670 ± 10°C. A part of the liquidus phase diagram dysprosium borate–dysprosium oxide in the range 0 to 25% dysprosium oxide was determined. (auth)

46779 FISSIOCHEMICAL PROCESS AND FUEL. Hamling, Bernard H. (to United States Atomic Energy Commission). U. S. Patent 3,514,373. 26 May 1970; Filed 16 Dec 1966.

A fissiochemical fuel is described that comprises the fibers of an oxide of one or more of the fissionable forms of thorium, uranium, and plutonium, either alone or in combination with another metal that is either in the elemental or in the oxide form. (auth)

46780 PREPARATION AND SUPERCONDUCTIVITY OF THE SESQUICARBIDE PHASE IN THE LANTHANUM–THORIUM–CARBON SYSTEM. Giorgi, A. L.; Szklarz, E. G.; Krikorian, N. H.; Krupka, M. C. (Los Alamos Scientific Lab., N. Mex.). J. Less-Common Metals; 22: 131-5(Sep 1970).

In earlier work on the high-pressure high-temperature preparation of yttrium sesquicarbide, the addition of thorium to the starting materials resulted in the formation of a ternary yttrium–thorium sesquicarbide with a marked increase in the superconducting transition temperature from 11.5 to 17.0°K. It was found that the addition of thorium to the lanthanum sesquicarbide preparation also resulted in the formation of a ternary lanthanum–thorium sesquicarbide, with an enhancement of the superconducting transition temperature. (auth)

46781 PREPARATION AND MECHANICAL PROPERTIES OF HOT-PRESSED ZIRCONIA–ZIRCONIA FABRIC COMPOSITES. Graves, G. A. (Univ. of Dayton, Ohio); Lynch, C. T.; Mazdiyasni, K. S. Amer. Ceram. Soc. Bull.; 49: 797-803(Sep 1970).

Ceramic fiber reinforced ceramic matrix composites were investigated for the zirconia-zirconia system. Ultrahigh purity submicron zirconia powder was combined with multilayers of zirconia fabric to produce a high density ceramic body with improved high temperature properties. Hot-pressing techniques were used to obtain a fine grained, high density matrix firmly bonded to the reinforcement layers without destruction of the layered composite. Modulus of rupture values were obtained to 1500°C. Modes of failure were examined by scanning electron microscopy. By using active powders with high surface energy to form the matrix of the ceramic composite, low-temperature low-pressure hot-pressing becomes feasible. (auth)

Properties Evaluations

Refer also to abstracts 46220, 46221, 46389, 46401, 46431, 46435, 46443, 46718, 46721, 46732, 46734, and 47892.

46782 (BNWL–1431) HIGH-TEMPERATURE THERMAL CONDUCTIVITY OF ROUND ROBIN URANIUM DIOXIDE. Bates, J. Lambert (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. Contract AT(45-1)-1830. 66p. Dep. CFSTI.

The thermal diffusivity of stoichiometric uranium dioxide was measured from 16 to 2500°C using a "flash" thermal diffusivity technique. The thermal diffusivity at lower temperatures was initially higher than expected during initial measurements. After heating to 1200°C or above, the low temperature diffusivity decreased to a reproducible value representative of nearly stoichiometric UO_2. This increased diffusivity is attributed to initially hypostoichiometric UO_2 which oxidized to a stoichiometric composition at 1200°C or above. Calculated thermal conductivity values agree within ±10% below 600°C and within ±5% above 600°C with other reported interlaboratory UO_2 values. The thermal conductivity exhibits a minimum near 1600°C. (auth)

46783 (GEAP–12099) A THERMODYNAMIC DATA PROGRAM INVOLVING PLUTONIA AND URANIA AT HIGH TEMPERATURES. Quarterly Report No. 11, February 1–April 30, 1970. Aitken, E. A.; Evans, S. K. (General Electric Co., Pleasanton, Calif. Nucleonics Lab.). Jul 1970. Contract AT(04-3)-189. 15p. Dep. CFSTI.

Research results are reported on vaporization of UO_2, distribution of O in UO_2–PuO_2 ceramics, thermodynamics of sodium-fuel reaction product behavior, and O equilibria in UO_2–PuO_2. (J.R.D.)

46784 (ORNL–4503(Vol.1)) THORIUM CERAMICS DATA MANUAL. VOLUME I. OXIDES. Peterson, Sigfred; Curtis, C. E. (Oak Ridge National Lab., Tenn.). Sep 1970. Contract W-7405-eng-26. 74p. Dep. CFSTI.

Physical, chemical, and mechanical properties of thorium oxide, alone and in combination with other oxides, are compiled from the literature through October 1969 (256 references). Thorium-oxygen phase information is followed by data collections on thorium oxide, binary systems with uranium and plutonium oxides, other binaries, and ternary and more complex systems. For each, sections on composition ranges and preparation and fabrication methods described as needed to understand their influence on properties are followed by compilations on crystal properties, thermodynamic properties, change of state, electrical and magnetic properties, heat and mass transport, mechanical properties, chemical properties, and surface properties. Compilations on the other ceramic compounds of thorium and revisions to this compilation are planned for future issue. (auth)

46785 (TRG-Report-1952) ELECTRON METALLOGRAPHY AND DIFFRACTION TECHNIQUES IN THE STUDY OF THE NEWER NUCLEAR FUELS. U.K.A.E.A. Diffraction Analysis Conference 17th Meeting at Durley Hall, Bournemouth, Thursday 2nd and Friday 3rd October 1969. Ferguson, I. F. (ed.) (United Kingdom Atomic Energy Authority, Springfields (England). Reactor Group). 1970. 40p. (CONF-691050). UK 7s.

Twenty papers were presented at the conference which reviewed the current status of electron metallography and x-ray diffraction in the U.K.A.E.A. Papers which are reproduced in full describe fuels for the Mark III gas-cooled reactors, the use of x-ray powder photography for work on coated fuel particles, use of a conventional x-ray diffractometer, morphological studies with the scanning electron microscope, and the thinning of electron microscope specimens by ionic bombardment. The remaining papers are summarized in the form of either extended or short abstracts. (UK)

46786 (WAPD-Trans-132) INVESTIGATIONS IN THE NIOBIUM–NITROGEN SYSTEM. I. CHANGES IN PROPERTIES OF NIOBIUM BY DISSOLVED NITROGEN. Gebhardt, E.; Duerrschnabel, W.; Hoerz, G. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from J. Nucl. Mater.; 18: 119-33(1966). 27p. Dep. CFSTI.

This paper was abstracted from the original language and appeared in NSA as 20: 13302.

46787 EFFECT OF CARBON ON ZIRCONIA AND ALUMINA BETWEEN 1000 AND 2000°K. Ribon, C. Bull. Dir. Etud. Rech., Ser. A; No. 4, 75-86(1969). (In French).

A theoretical study of the effect of carbon on zirconia and alumina over the 1000 to 2000°K temperature range was carried out to find an explanation for an incident which had occurred during endurance tests on an experimental oven prototype for the CORINE

loop, which was intended for use in thermal power station boiler corrosion research. The graphite electrodes had attacked the zirconium centering components, resulting in the formation of a body of metallic appearance and partial melting of the alumina bricks. A thermodynamic study showed that carbon reduced zirconia to zirconium carbide above 1030°K. (auth)

46788 NONFUELED REFRACTORIES. Lankard, D. R. Reactor Mater.; 13: 132-4(1970).

Results of research are summarized on structural ceramics such as NbC, rare earth oxides, and concretes. (J.R.D.)

46789 PROPERTIES AND USES OF HIGH-MELTING HARD MATERIALS. Merz, Alfred (Zentralinstitut fuer Festkoerperphysik und Werkstoffforschung, Dresden). Neue Huette; 15: 159-65(Mar 1970). (In German).

Carbides, nitrides, borides, and silicides of transition metals within the fourth to the sixth group of the periodic system possess not only metallic properties but also those that are typical for nonmetals. Present attempts to explain these properties from the atomic structure are summarized and the frequently contradictory concepts discussed. Approaches for further research are outlined. Properties and application of hard materials for industrial purposes are summarized. (tr-auth)

46790 ADSORPTION BEHAVIOR OF THORIUM OXIDE. I. KINETICS OF ADSORPTION OF ETHANOL, ETHYL ETHER, AND WATER. Knoezinger, Helmut; Jeziorowski, Helge (Univ., Munich). Surface Sci.; 22: 111-24(Aug 1970). (In German).

From adsorption kinetics the intraparticle diffusion coefficients for water, diethyl ether, and ethanol were calculated for a microporous thorium oxide sample to be of the order of 10^{-12} to 10^{-14} cm^2/sec in the temperature range between 100 and 200°C at 80 torr. It can be shown that the mass transport proceeds in the adsorbed phase only, most probably by hydrodynamic flow of an adsorbed liquid film. (auth)

46791 STRAIN-ENERGY MODEL FOR SOLID SOLUBILITY LIMITS IN Zr + H SYSTEM. Sinha, V. K.; Shetty, M. N.; Singh, K. P. (Indian Inst. of Tech., Kanpur). Trans. Faraday Soc.; 66: 1981-6(Aug 1970).

A strain-energy model is developed to estimate the saturation solid solubility limits of hydrogen in the different phases present in Zr + H system. The model requires all the hydrogen atoms to occupy interstitial sites in a perfect parent lattice. At higher temperatures the model takes into account the reduction in the number of accessible interstitial sites brought about by thermal disorder in the parent lattice. The calculations are also extended to the Ti + H system. The model fits well with these two systems. (auth) (UK)

46792 ANODIC PROPERTIES OF TITANIUM AND NIOBIUM CARBIDES. Cihal, Vl. (Research Inst. for Materials Protection, Prague); Desestret, A.; Wagner, G.-H.; Froment, M. Corros.-Trait., Prot., Finition; 18: 213-17(Jun-Jul 1970). (In French).

Outlines of the polarization curves for titanium and niobium carbides in aqueous solutions of sulfuric and nitric acids are given. The differences in the anodic properties of these two compounds help to explain those recorded during the corrosion of titanium or niobium stabilized stainless steels containing these carbides. (auth) (France)

46793 ELASTIC CONSTANTS OF COMPRESSION-ANNEALED PYROLYTIC GRAPHITE. Blaksiee, O. L.; Proctor, D. G.; Seldin, E. J.; Spence, G. B.; Weng, T. (Parma Tech. Center, Ohio). J. Appl. Phys.; 41: 3373-82(Jul 1970).

The elastic constants of pyrolytic graphite which has been highly ordered by annealing under compressive stress were determined by ultrasonic, sonic resonance, and static test methods. Ultrasonic tests yielded the elastic constants c_{11}, c_{12}, c_{33}, $c_{44} = 1/s_{44}$, and the stress derivative of c_{33}. The moduli $1/s_{11}$ and c_{44} were determined from the free flexural resonant vibrations of bars, and the shear modulus c_{44} also was determined from the fundamental torsional resonance of the bars and from the resonance of compound torsion oscillators composed of thin graphite disks with steel end pieces. Static tension, compression, and torsion tests on the pyrolytic graphite yielded a complete set of compliances (s_{11}, s_{12}, s_{13}, s_{33}, and s_{44}). The following self-consistent set of elastic constants (c_{ij} in units of 10^{11} dyn/cm^2; s_{ij} in 10^{-11} cm^2/dyn) was deduced from the results: $c_{11} = 106 \pm 2$, $c_{12} = 18 \pm 2$, $c_{33} = 3.65 \pm 0.10$, $c_{13} = 1.5 \pm 0.5$, $c_{44} = 0.018$ to 0.035, $1/s_{11} = 102 \pm 3$, $1/s_{33} = 3.65 \pm 0.10$, $s_{12} = -0.0016 \pm 0.0006$, $s_{13} = -0.0033 \pm 0.0008$, and $s_{66} = 0.023 \pm 0.002$; with the possible exception of c_{44}, these constants are expected to be typical of the graphite single crystal. The shear strength for shear between basal planes was found to be in the range of 90 to 250 g/mm^2. (auth)

Structure and Phase Studies

Refer also to abstract 46749.

46794 (LA-tr-70-20) ON THE DIFFUSION MECHANISM IN TRANSITION-METAL MONOCARBIDES. Zagriazkin, V. N. Translated by Helen J. Dahlby (Los Alamos Scientific Lab., N. Mex.), from Fiz. Metal. Metalloved.; 28: 292-7(1969). 9p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 12409.

46795 ELECTRON DIFFRACTION STUDY ON THE "SHEAR STRUCTURE" OF V_nO_{2n-1}. Kosuge, Koji (Kyoto Univ.); Okinaka, Hideyuki; Kachi, Sukeji; Nagasawa, Koichi; Bando, Yoshichika. Jap. J. Appl. Phys.; 9: 1004(Aug 1970).

The results of an electron diffraction study of the shear structure of V_nO_{2n-1} (n is integer) are reported. (G.M.C.)

46796 DISLOCATION ETCH PITS ON BASAL, PRISMATIC, AND PYRAMIDAL PLANES OF SINGLE-CRYSTAL BERYLLIUM OXIDE. Digiallonardo, S. L.; Vandervoort, R. R. (Univ. of California, Livermore). Metallography; 3: 215-17(Jun 1970).

Following deformation of monocrystalline BeO the dislocations on the basal, first-order prismatic, second-order prismatic, and pyramidal planes were studied. The crystal structure of BeO was found to be noncentrosymmetric. (G.M.C.)

46797 U-UO_2-UN_2 PHASE DIAGRAM. Benz, Robert; Balog, George; Baca, B. H. (Los Alamos Scientific Lab., N. Mex.). High Temp. Sci.; 2: 221-51(Sep 1970).

Various phase regions were deduced from metallographic, Debye-Scherrer, and high-temperature x-ray diffraction, and chemical analysis data. The monotectic temperature in the U-UO_2 system, 2480°, was lowered by addition of nitrogen to 2340 ± 30°. A 4-phase, UO_2 + UN + L_1 + L_2 (L denotes liquid), stationary point existed at 2340°. At the UO_2-UN pseudo-binary eutectic, 2610 ± 40° and 0.55 ± 0.15 atm N_2, solubility of nitrogen in the UO_2 phase was 4 atomic %. Both U and oxygen dissolved to an appreciable extent in UN coexisting with U(l) + UO_2. The atomic solubilities of U and oxygen were approximately the same with a maximum of 3 atomic % at 2100°. A complete series of solid solutions (SS) existed between CaF_2-type UO_2 and Mn_2O_3-type α-U_2N_3 at temperatures above 1350°. A 3-phase region existed between UN, hexagonal β-U_2N_3, and $UO_{0.27}N_{1.22}$ (SS′) at 1400°. The SS′ composition in the 3-phase mixture at 1200° was $UO_{0.22}N_{1.33}$. (104 references). (auth)

45798 REACTION KINETICS OF THE INTERACTION OF YTTRIUM AND NEODYMIUM OXIDES WITH COPPER OXIDES IN THE SOLID PHASE. Savchenko, V. F.; Rubinchik, Ya. S. Vestsi Akad. Navuk BSSR, Ser. Khim. Navuk; No. 2, 58-61(Feb 1970). (In Russian).

Kinetics of reactions in the CuO-Y_2O_3 system were studied at 775 to 850°C and in the CuO-Nd_2O_3 system at 725 to 825°C. Mathematical evaluation of the experimental data showed that the reactions of the first system took place in the kinetic region and were limited by the processes at the boundary of the phases. In the second system the reaction took place in the diffusion region and was the result of copper oxide diffusion at the boundary between neodymium oxide and the product of the reactions. The activation energies of the reactions were 110 and 69.5 kcal/mole respectively. It was also shown that the diffusion reflection spectra can be used for determining the reaction kinetics in the Nd_2O_3-CuO system. (tr-auth) (INIS)

46799 ETA OXIDES AND NITRIDES OF HAFNIUM-NICKEL, TANTALUM-NICKEL, AND TUNGSTEN-NICKEL. Kotyk, Michael. Raleigh, N. C.; North Carolina State Univ. (1969). 78p. University Microfilms Order No. 70-9166.

Thesis.

A study was made of the effect of oxygen and nitrogen on the stabilization of the eta-carbide type structure in hafnium-, tantalum-, and tungsten-based alloys containing up to 50 atomic percent nickel. In the hafnium-nickel system, the eta phase is stable at 1000°C for compositions containing between 2 and 8 atomic percent of oxygen and hafnium to nickel ratio of 2:1. The unit cell size varied from 12.11 Å to 12.14 Å. A very ternary compound, stabilized by oxygen and having an approximate composition of $Hf_{48}Ni_{24}O_8$, existed in equilibrium with eta. The eta phase was found to be non-existent at 1000°C in both the tantalum-nickel-oxygen and the tungsten-nickel-oxygen systems. Only the binary metal and oxide phases were identified in metallographic and powder diffraction studies. Additions of nitrogen to the oxygen-bearing systems resulted in stabilization of eta in both systems. Virtually unchanging lattice parameters of 11.54 and 10.89 Å for the tantalum-based and tungsten-based eta phases, respectively,

indicate stability within very narrow compositional limits. Eta nitrides were prepared for both the hafnium–nickel and tantalum–nickel alloys. In the hafnium-based system, eta nitride with a unit cell size of 12.065 Å coexisted with HfN and a second nitrogen-stabilized ternary compound. In the tantalum-based system, eta nitride with a unit cell size of 11.54 Å is believed to be stable over a very small compositional range and at a tantalum-to-nickel ratio of 2:1. (Diss. Abstr. Int., B)

46800 STUDIES OF THE DIVALENT RARE EARTH OXIDES. McCarthy, Gregory Joseph. University Park, Pa.; Pennsylvania State Univ. (1969). 105p. University Microfilms Order No. 70-7231.

Thesis.

The rare earth elements which are known to possess a divalent oxidation state in compounds are samarium, europium and ytterbium. Single and mixed oxides of divalent europium have been known for more than a decade and are of considerable interest because of their magnetic and optical properties. There have been a number of reports of preparations of divalent samarium and ytterbium oxides. However, recent studies have indicated that these oxides may not be stable phases at low and moderate temperatures. The existence of these divalent rare earth oxides and the factors which may influence their stability were investigated. Direct preparation of the rare earth monoxide by reduction of the sesquioxide with the corresponding rare earth metal was attempted. Europium monoxide was easily prepared by this method, but samarium and ytterbium monoxides could not be prepared. The phase relations in a 1400°C isotherm of the systems Eu–Ti–O, Sm–Ti–O and Yb–Ti–O were investigated. In the system Eu–Ti–O the following ternary phases were prepared: Eu_2TiO_5, $Eu_2Ti_2O_7$, Eu_2TiO_4, $Eu_3Ti_2O_7$, $Eu_4Ti_3O_{10}$, $(EuTiO_3)8S$ and $EuTi_{12}O_{19}$. In the latter five phases the europium was found to be divalent. Only trivalent rare earth ternary phases were found in the systems Sm–Ti–O and Yb–Ti–O. Substitutions of $Sm^{3+}Ti^{3+}O_3$ into $Sr^{2+}Ti^{4+}O_3$ failed to stabilize even a small amount of Sm^{2+}. Efforts to reproduce the previously reported preparations of divalent samarium and ytterbium silicates were also unsuccessful. All these experiments confirmed the hypothesis that single and mixed oxides of divalent samarium and ytterbium are unstable at low and moderate temperatures. Some approximate thermodynamic calculations were performed and they confirm the experimental results. The stability of the binary oxides, halides and chalcogenides of divalent samarium and ytterbium was correlated to the electronegativity of the anion. The degree of anisodesmicity of the bonding in the stable divalent sulfates, carbonates and phosphates of samarium and ytterbium was contrasted to that of the unstable oxides with some success. (Diss. Abstr. Int., B)

46801 ELECTRON DENSITY ANALYSIS OF THE TERNARY BORIDES $Co_{21}Ta_2B_6$ AND $Ni_{21.05}Sn_{1.95}B_{6.5}$. Davis, Hubert Hartman Jr. Raleigh, N. C.; North Carolina State Univ. (1969). 84p. University Microfilms Order No. 70-9178.

Thesis.

An electron density analysis for ternary borides $Co_{21}Ta_2B_6$ and $Ni_{21.05}Sn_{1.95}B_{6.5}$ was carried out in an attempt to determine the type of bonding and the electron density distribution existing about the c position for the $D8_4$ structure of these compounds. A nonintegrating Weissenberg single crystal method was used to gather intensity data for $Co_{21}Ta_2B_6$, while a Guinier–Jagodzinski focusing camera arrangement was used to analyze a powder sample of $Ni_{21.05}Sn_{1.95}B_{6.5}$. Electron density sections for the two compounds were calculated using a Fourier series summation, with the results showing that the tantalum atom must give up one electron in order to occupy the c position in $Co_{21}Ta_2B_6$, while the tin atom is only partially ionized in the Ni–Sn–B tau phase. In both cases the structure is ordered. Theoretical and experimental electron density distributions for $Co_{21}Ta_2B_6$ were evaluated, an extra peak, approximately the size expected for boron, was observed in a normally unoccupied site in the real electron density section. This peak did not appear in the Ni–Sn–B electron density section, and its origin was shown not to be due to series termination effects. The possibility of a boron atom occupying this position is discussed. (Diss. Abstr. Int., B)

46802 CRYSTAL STRUCTURE OF THE COMPOUND $YCrB_4$ AND ITS ANALOGS. Kuz'ma, Yu. B. (Lvov State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 15: 312-14(Sep-Oct 1970). Translated from Kristallografiya; 15: 372-4(Mar-Apr 1970).

The crystal structure was investigated on a single crystal containing 20 at.% Y, 20 at.% C, and 60 at.% B. The lattice constants of $YCrB_4$ as determined by x-ray powder diffraction are: a = 5.972 Å, b = 11.46 Å, c = 3.461 Å, and V = 236.9 Å^3. The space group Pbam–D^1_{2h} and Pbaz–C^1_{2v}, and the unit cell contains four $YCrB_4$ units. The projection of the interatomic P(uv) function was analyzed. The atomic parameters and the interatomic distances in the $YCrB_4$ structure are tabulated. Isostructural $RCrB_4$ compounds were found in R–Cr–B systems, where R = Gd, Tb, Dy, Ho, Er, and Lu; no such compounds were found for Yb and Sc. (D.L.C.)

46803 METAL–INSULATOR TRANSITION IN V_2O_3 IN A STRONG ELECTRIC FIELD. Valiev, K. A.; Kipaev, Yu. V.; Mokerov, V. G.; Rakov, A. V.; Solov'ev, S. G. JETP Lett. (USSR) (Engl. Transl.); 12: 12-14(5 Jul 1970). Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 18-22(5 Jul 1970).

The metal–insulator phase transition in V_2O_3 in an electric field U_b was investigated by the electroreflection method at $1.1 \leq h\omega \leq 6$ eV at 300 to 360°K. The spectra of $[(1/R)(dR/dU)]$ vs $h\omega$ are little affected by U_b until U_b reaches 2V; the strongest change in amplitude occurs for $h\omega \leq 2.5$ eV. It is proposed that the transition occurs in this U_b region, with the insulator phase being the high-temperature phase, and that a simultaneous transition to a ferroelectric state also occurs. Explanations are given for the anomalous dependence of $[(1/R)(dR/dU)] = f(U_b)$ and for the maximum amplitude change at $h\omega \leq 2.5$ eV. (D.L.C.)

46804 LANTHANIDE OXYCARBIDES: PHASE AND EQUILIBRIUM STUDIES. Butherus, Alexander Duane. East Lansing, Mich.; Michigan State Univ. (1969). 139p. University Microfilms Order No. 70-9507.

Thesis.

Results of studies on two different Ln(O,C) phases (Ln = lanthanide) are reported. The $Ln_2O_2C_2$ phase has been prepared only for Ln = Nd, La. The Ln_4O_3C phase appears more general and has been prepared for Ln = La, Nd, Gd, Ho, Er. The $Ln_4O_2C_2$ system has been studied quite thoroughly thermodynamically, though less so structurally. The Ln_4O_3C system on the other hand has been more thoroughly studied structurally. (Diss. Abstr. Int., B)

46805 CRYSTAL GROWTH IN POLYCRYSTALLINE CERAMIC AGGREGATE. Accary, A. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Int. Hautes Temp. Refract.; 72: 106-14(Apr-Jun 1970). (In French).

Principal mechanisms of crystal growth in polycrystalline metallic aggregate are given: primary recrystallization, growing of grains, secondary recrystallization, and non-continuous growing. The study of uranium monocarbide and mononitride showed how these different processes could occur in ceramics with some new phenomena: growth of idiomorphic grains, welding without boundaries, when an intergranular metallic phase, either liquid or solid, was existing. The theory of grain growth could not explain the observations made with uranium mononitride, probably because the theory did not include anisotropy of crystalline superficial energy. Crystal growth in polycrystalline ceramic aggregate could be applied first to the evaluation of temperatures (rough approximation); then to the growth of single crystals with high purity and crystalline perfection. (auth) (France)

46806 NEW PHASES OF THE SYSTEM TbO_y–La_2O_3. Sibieude, Francois (CNRS, Montlouis, France). Compt. Rend., Ser. C; 270: 130-3(15 Jul 1970). (In French).

The experimental conditions used reveal four new phases ψ_1, ψ_2, ψ_3, and ψ_4 related to the hexagonal structure A (La_2O_3). The powder diagrams are characterized by a splitting of the diffraction lines related to the faces such as (101), (102), (103), and (201). The indexation of the diagrams attributes to the phases ψ and hexagonal structure derived from the structure 2H by a change in the stacking of the cationic layers. The hexagonal structure ψ_1 is made up of 25 layers (25H). The phases ψ_2, ψ_3, and ψ_4 can be indexed according to the rhombohedric system: 15 R, 9 R, and 12 R. (auth) (France)

46807 TERNARY COMPLEX BORIDES IN THE SYSTEMS: (Mo,W)–(Ru,Os)–B AND W–Ir–B. Rogl, P.; Nowotny, H.; Benesovsky, F. (Univ., Vienna. Metallwerk Plansee AG, Reutte/Tyrol, Austria). Monatsh. Chem.; 101: 850-4(May-Jun 1970). (In German).

The ternary compounds (Mo, Ru)B and (W, Ru)B crystallize with the FeB-type structure; (Mo, Os)B_2, (W, Os)B_2, and (W, Ir)B_2 were found to be isotypic with ReB_2. (auth)

46808 ELECTRON MICROSCOPIC STUDY OF PLANAR INTERFACES RESULTING FROMTHE MONOCLINIC TO TETRAGONAL PHASE TRANSITION IN VO_2. Hayashi, Y. (SCK-CEN, Mol, Belgium); Van Landuyt, J.; Amelinckx, S. Cryst. Lattice Defects; 1: 185-8(1970).

Vanadium dioxide has a monoclinic to tetragonal phase transformation at about 70°C. This transformation can be directly observed in the electron microscope. Partial transformation allows the boundaries between the two phases to be studied. If the tetragonal phase is transformed into monoclinic the crystal is broken

up into domains according to different modes of transformation. The resulting different types of interfaces between domains are predicted and compared with observations. (auth)

46809 ELECTRICAL CONDUCTIVITY STUDY ON PHASE TRANSITIONS IN U_3O_8. Ishii, Tamotsu (Tokyo Univ.); Naito, Keiji; Oshima, Keichi. J. Nucl. Mater.; 35: 335-45(Jun 1970).

Electric conductivity measurements were carried out for U_3O_{8-z} and U_3O_{13+v} pellets. Two kinds of transitions were observed from the measurement of log σ vs 1/T curve: the orthorhombic to hexagonal transition in α-U_3O_8 and the U_3O_{13+v} to U_3O_{8-v} transition. The transition temperature in α-U_3O_{8-z} increased with decreasing O/U ratio, in particular, in the nearly stoichiometric U_3O_8 region an abrupt variation of the transition temperature was observed. The phase diagram around the U_3O_8 region was estimated on the basis of the electrical conductivity data. (auth)

46810 CRYSTAL STRUCTURE OF LOW TEMPERATURE ORTHORHOMBIC PHASE $ThMo_2O_8$. Thoret, Jean; Rimsky, Alexandre; Freundlich, William (Paris Univ.). Compt. Rend. Ser. C; 270: 2045-7(22 Jun 1970). (In French).

Monocrystals of low temperature phase $ThMo_2O_8$ were prepared. The lattice parameters are: a = 9.74 Å, b = 10.22 Å, and c = 14.46 Å. The measured density equal to 5.01 leads to eight groups. A space group P_{cab} with a mmm symmetry class was observed. The thorium atom was found to be nearly in the center of a twelve-sided polyhedron the eight tops of which are occupied by oxygen atoms. (auth) (France)

46811 PHASE EQUILIBRIA IN THE VANADIUM-OXYGEN SYSTEM. Anderson, J. S.; Khan, A. S. (Oxford Univ.). J. Less-Common Metals; 22: 209-18(Oct 1970).

Phase equilibria in the V_2O_3-VO_2 system were established by varying the oxygen partial pressures at a number of temperatures. The phases, V_2O_3, V_4O_7, V_5O_9, V_6O_{13}, and V_7O_{13}, were shown to exist as stable phases of definite composition up to 1423°K. Oxygen pressures in equilibrium with the vanadium oxides were determined by equilibration with CO/CO_2 or CO_2/H_2 mixtures, and the standard free energies of the various vanadium oxides were calculated. Revised free energy data are given for the reaction $V_2O_3 + \frac{1}{2}O_2 = 2VO_2$. The results are also used to construct the vanadium-oxygen phase diagram between the compositions $VO_{1.18}$ and VO_2 at the range of temperature studied. (auth)

Radiation Effects

Refer also to abstracts 46757, 47299, and 47305.

46812 (CEA-CONF-1564) PREPARATION OF SAMPLES BY MICRO-MACHINING. Hayet, L. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1970. 37p. (In French). (CONF-700523-2). Dep. CFSTI (U. S. Sales Only).

From 12th Meeting on Hot Laboratories, Cadarache, France.

Studies of fission products, stoichiometry, and fuel cladding reactions in irradiated plutonium fuel elements require small quantity sampling and accurate machining. According to the nature of the examinations to be carried out, sampling involves either exact positioning, very high precision, or rapid preparation. Various tools used such as lathes, fast cutters, ultrasonic machining tools, micro-sampling devices for powders, and dental mechanic's milling tools are reviewed and different sampling methods are described. Most of the machines are adapted from standard types; only the mechanical micro-sampling equipment is a specific item. (auth) (France)

46813 (DP-Report-227) IRRADIATION BEHAVIOUR OF COATED PARTICLE FUEL. Project DRAGON. Sayers, J. B.; Rose, K. S. B.; Coobs, J. H.; Hauser, G. P.; Vivante, C. (Atomic Energy Establishment, Winfrith (England)). Oct 1963. 60p. Dep. CFSTI.

Irradiation experiments were carried out on a variety of carbide fuels coated with either pyrocarbon or composite pyrocarbon-SiC coatings. Both static capsule and gas cooled loop experiments were performed covering a range of burn-ups up to 14% of initial metal atoms. In the higher burn-up range, covering up to 14% of initial metal atoms (2×10^{21} fission/cm^3), all the particles had fully enriched sintered UC_2 kernels with porosities in the range 30 to 50%. They were coated with two or three distinct pyrocarbon coatings, and tested both in compact form and as unsupported particles. The results showed that this type of particle could withstand a burn-up of 8% at temperatures below 1300°C with very low failure rate. Above 8% burn-up the data are solely from particles in compacts and although failure can normally be attributed to an advanced form of spearhead attack, there is also some evidence to suggest that this had been aggravated by external corrosive effects. In the lower burn-up range, up to 2.6% of initial metal atoms (3×10^{20}-10^{21} fission/cm^3 depending on kernel type and density), both-sintered and melted (Th,U)C_2, and melted (Zr,U)C particles coated with a triplex pyrocarbon coat were irradiated at temperatures up to 1400°C only in compact form. Sintered (Zr,U)C particles coated with various types of pyrocarbon coatings were irradiated similarly at temperatures up to 1700°C. The melted (Th,U)C_2 kernels cracked under irradiation causing stress cracking in all the coating layers, whereas in the sintered type no failed coatings were found nor were any diffusional effects observed in the SiC layer. The melted (Zr,U)C kernels did not show this cracking, but metallographic examination showed them to be polycrystalline and less dense than the thorium containing kernels. No diffusion of the sintered (Zr,U)C into the pyrocarbon coating was observed in spite of the high irradiation temperatures. Only tentative comparisons between pyrocarbon and composite pyrocarbon-SiC as coatings, or UC_2 as opposed to alloyed kernels are possible with the present data, as the burn-up and temperature ranges covered hardly overlap. Two phenomena which appear to have a marked influence on particle behavior are discussed in some detail: the occurrence of a low temperature sintering phenomenon attributable to irradiation; and the so-called spearhead attack in pyrocarbon which is tentatively ascribed to fission fragment recoil damage causing ordering and possibly graphitization of the pyrocarbon, resulting in a shrinkage. The initiation of the cracks in the pyrocarbon coating may be due to chemical attack by fission products. (auth)

46814 (DP-Report-422) RECENT STUDIES ON PYROLYTIC CARBON COATINGS ON FUEL PARTICLES. Project DRAGON. Walther, H.; Chinaglia, B.; Cocito, G.; Domenici, M.; Drago, A. (Atomic Energy Establishment, Winfrith (England)). Jun 1966. 42p. Dep. CFSTI.

Work is described on methods for measuring the diffusion coefficient and the activation energy for ^{133}Xe in radial direction in the coating. The uranium migration into the coating was also investigated under drastic out of pile conditions during 300 hr at 1900°C, and during thermal cycling up to 1900°C. The results indicate that uranium migration is more severe in samples of high porosity. In other work it was found that variations in coatings which are liable to cause fracture are more pronounced when the deposition temperature is lower than the subsequent heat treatment temperature. Lower porosity coatings were found to be less susceptible to fission fragment damage. A model for fast neutron damage in coatings is included. (J.R.D.)

46815 URANIUM-PLUTONIUM MIXED OXIDE SOL-GEL IRRADIATION EXPERIMENTS. Lepscky, C.; Rotoloni, P. L.; Testa, G.; Trezza, G. (CNEN, Rome). Nucl. Appl. Technol.; 9: 536-49(Oct 1970).

Uranium-plutonium mixed oxide sol-gel fuel is attracting interest as a promising nuclear material for fast reactor fuel subassemblies. However, this material, if employed for commercial fuel production, particularly in the fast reactor area, must be extensively tested both in-pile and out-of-pile. For this purpose some irradiation tests were carried out by CNEN in the RS-1 swimming pool reactor in Italy and in the Halden BHWR in Norway under the Plutonium Program and the Fast Reactor Program. The results obtained show in-reactor homogenization of plutonium in the UO_2 matrix, the integral of conductivity before and after the in-pile sintering process has taken place increases, and the cladding is attacked by impurities originally present in the fuel particles. (auth)

46816 BURST STRENGTH OF EBR-II IRRADIATED FUEL PIN SECTIONS. Fish, R. L.; Holmes, J. J.; Leggett, R. D. (WADCO, Richland, Wash.). Nucl. Appl. Technol.; 9: 528-35 (Oct 1970).

Burst tests were conducted at 900°F on specimens prepared from 75% UO_2-25% PuO_2 fuel pins clad with 0.250 in. OD × 0.016 in. wall type 304 stainless steel (PNL 1-3 and 1-6) that were irradiated in EBR-II to ~8500 MWd/Mtm at 8 to 9 kW/ft. Argon gas was used internally to pressurize the fuel pin sections. The fuel was left intact in order that the effects of the fuel and fission products on the properties of the cladding could be determined. Specimens taken from above the midplane but within the fuel column exhibited brittle, intergranular fracture at drastically lower stresses (~30,000 psi) than would be expected from Type 304 stainless steel irradiated under similar conditions. The measurable strain in these specimens was less than 1%. Fueled specimens from below the midplane and specimens from the fission gas plenum exhibited a ductile, transgranular fracture at stresses and strains normally expected of Type 304 stainless steel irradiated under these conditions, i.e., ~60,000 psi and ~9% strain.

Post-test examination of the burst test specimens included diameter measurements, optical metallography and electron microscopy. Fueled specimens from above the midplane contained $M_{23}C_6$ and sigma phase at the grain boundaries of the cladding whereas the cladding of specimens from below the fuel midplane was free of grain boundary precipitates. The tests revealed that sections of irradiated fuel pins may fail at much lower stresses and strains than would be expected from mechanical tests conducted on unfueled cladding material. The premature failure in certain sections of the pin is associated with grain boundary precipitation in the cladding. The precipitation is believed to promote chemical attack along the cladding boundaries where the chemical specie is either a fission product or a reaction product produced from their interaction with the hot cell environment. (auth)

Plastics and Other Materials

Refer also to abstracts 46251, 46284, 46450, and 46757.

46817 RADIOISOTOPIC TRACER STUDY OF CARBON FORMATION IN ETHANOL–AIR DIFFUSION FLAMES. Lieb, D. F.; Roblee, L. H. S. Jr. (Univ. of Massachusetts, Amherst). Combust. Flame; 14: 285-96(Jun 1970).

Experimental results were obtained which show that carbon formation in ethanol-air diffusion flames occurs preferentially from the nonhydroxylated carbon atom of the ethanol molecule. The ratio of the contribution to solid carbon of the nonhydroxylated carbon atom to that of the hydroxylated atom equals 2:1. These findings support a proposed carbon formation mechanism, which is based on previous experimental observations and theoretical considerations. In order to define the overall reaction paths of each of the carbon atoms a radioisotopic tracer technique is developed. Ethanol-1-^{14}C and ethanol-2-^{14}C fuels are burned in a specially designed diffusion burner, and the radioactivities of collected samples of solid carbon are measured. A comparative analysis of the specific activities of the fuels and carbon samples defines the contribution of each of the carbon atoms to solid carbon. The technique proves to be a useful, quantitative tool for carbon formation research. In addition to the well-defined conclusions of the investigation, the particular numerical results suggest that carbon formation may be controlled by the selective one-to-one addition of two- and one-carbon fragments present in the flame— a new and intriguing explanation of the carbon formation phenomenon. This novel suggestion is discussed in light of the present and previous experimental observations. (auth) (UK)

46818 REENTRY PROTECTION FOR RADIOISOTOPE HEAT SOURCES. Bustard, Thomas S.; Princiotta, Frank T.; Barr, Harold N. (Hittman Associates Inc., Columbia, Md.). Nucl. Appl. Technol.; 9: 572-83(Oct 1970).

A new reentry protection material has been developed which acts as a thermal switch. It is a composite material, consisting of a ceramic foam uniformly impregnated with a metal which coats the ceramic foam structure. The composite is a thermal conductor ($k \cong 5$ Bth/ft-hr-°F) below the melting point of the metal impregnant and switches to an insulator ($k \cong 0.1$ Btu/ft-hr-°F) above its melting point. This switching effect is irreversible. Materials investigated to date are silica, alumina, and zirconia foams with silver and copper as the metal impregnants. These combinations yield a thermal switch which is activated at the melting point of the impregnants, i.e., 1762°F for silver and 1982°F for copper. Other metals can be utilized to increase or decrease the switching temperature. These composite materials have specific application to radioisotope fueled space power systems. For this application, the material selected would be placed around the fuel capsule, allowing the heat to pass through with only a small temperature differential incurred. When exposed to a reentry heat pulse, the material would switch to an insulator, thereby allowing intact and safe reentry of the capsule. Thermal conductivity testing and plasma jet testing have been performed and indicate that the composite material is an effective reentry protection material. (auth)

46819 DEGRADATION OF VARIOUS RUBBER AND PLASTIC INSULATED WIRES, AND COMPOUNDS IN EXPOSURE TO γ-RAY RADIATIONS. Morita, Minoru; Kurihara, Tadashi; Miyazawa, Kiyozumi; Hansai, Misao; Hasegawa, Masaru (Showa Electric Wire and Cable Co. Ltd., Kawasaki, Japan). Showa Densen Denran Rebyu; 20: 24-30(Jan 1970). (In Japanese).

Various insulated wires and their insulating compounds were exposed to γ-radiation, and the degradation of their electrical and physical properties was studied. The exposure was performed at 20°C and 40% relative humidity and at 66°C and 100% relative humidity. The γ-radiation dose was between 1 and 50 MR. From the test results, it was found that butyl rubber became soft and adhesive at high radiation dose, and silicone rubber degraded largely in a high temperature and humidity atmosphere. On the electrical properties, it was found that the volume resistivity of polyvinylchloride and cross-linked polyethylene lowered, but the latter still retained insulating property for practical use. (auth) (Japan)

PHYSICS (GENERAL)

Astrophysics and Cosmology

Cosmic Ray Exposure Ages

46820 THALLIUM CONTENTS OF CHONDRITES. Laul, J. C.; Pelly, I.; Lipschutz, M. E. (Purdue Univ., Lafayette, Ind.). Geochim. Cosmochim. Acta; 34: 909-20(Aug 1970).

The thallium contents of a number of equilibrated and "primitive" stony meteorites, i.e., carbonaceous (C) and unequilibrated ordinary chondrites (UOC), have been determined by neutron activation analysis. The technique has been proved by analysis of a synthetic sample and eight standard rocks in which Tl and Rb vary directly over concentration ranges of a factor of about 2000 for each. The chondritic analyses confirm Tl to be a "strongly-depleted" element. The mean Tl abundances in groups C1, C2, and C3 are 96, 46, and 32 atoms/10^9 Si atoms respectively, which lead to ratios (relative to C1) of C1 : C2 : C3 = 1.00 : 0.48 : 0.33, nearly the same as those predicted by a two-component model. The Tl contents of 11 UOC are intermediate to those of carbonaceous and equilibrated ordinary chondrites and decrease exponentially with increasing equilibration of the silicate phases. The trends exhibited by Tl and other "strongly-depleted" (i.e., Bi, C, In, and primordial Ar, Kr, and Xe), "normally-depleted" and "undepleted" elements are compared in ordinary chondrites. The Bi and Tl results suggest that the UOC and carbonaceous chondrites were not formed seriatim but that during formation of these chondrites, these elements were affected equally. (auth) (UK)

46821 AGES OF THE ALLENDE METEORITE. Fireman, E. L.; DeFelice, J. (Smithsonian Astrophysical Observatory, Cambidge, Mass.). Geochim. Cosmochim. Acta; 34: 873-81(Aug 1970).

The rare gases and the K and U were measured in whole-rock and chondrule samples of the allende meteorite, a Type-3 carbonaceous chondrite. There is an enrichment of the ^{4}He, ^{40}Ar, K, and U, and a depletion of the primordial gas in the chondrules. The U, Th–^{4}He age of the chondrules is $(4.2 \pm 0.2) \times 10^9$ years, and the K–^{40}Ar age of the chondrules is $(4.44 \pm 0.14) \times 10^9$ years. The chondrules are gas tight and old. With a maximum but reasonable correction for primordial ^{4}He, the U, Th–^{4}He age of the whole rock is $(3.4 \pm 0.2) \times 10^9$ years. The K–^{40}Ar age of the whole rock is 4.55×10^9 years, but this determination is less reliable than that for the chondrules because of the primordial Ar. The chondrules are enriched in excess ^{129}Xe and depleted in primordial Xe. The ^{129}Xe/^{132}Xe ratios and the ^{129}Xe excess in the chondrules are exceptionally high. Two troilite-bearing chondrules have a ^{129}Xe/^{132}Xe ratio of 92, which is the highest ever observed, and a ^{129}Xe excess of 4.1×10^{-8} cc/g, which is also very large. For chondrules, which contain little primordial Xe, the I contents can be obtained from the ^{128}Xe excesses, the ^{60}Co content, and the exposure age. In spite of the high ^{129}Xe excesses, the I contents of the chondrules are not very high, ranging from 59 to 135 ppb. The $(^{129}Xe/I_{max})$ ratios range from 0.42 to 1.39×10^{-4}. Some chondrules of Allende may predate slightly the I–^{129}Xe isochronism in chondrules even with no ^{129}Xe loss. (auth) (UK)

46822 DETERMINATION OF NITROGEN IN IRON METEORITES. Goel, P. S. (Indian Inst. of Tech., Kanpur). Geochim. Cosmochim. Acta; 34: 932-5 (Aug 1970).

Nitrogen was determined in Odessa and Canyon Diablo iron meteorites by three different methods: thermal neutron activation, Kjeldahl distillation, and alkali fusion. The nitrogen contents vary from 25 to 240 ppM. Large variations are observed even in adjacent pieces. Nitrogen minerals are apparently nonuniformly distributed in the metal. (auth) (UK)

46823 ACTIVITY OF THE DOSSO METEORITE (WHICH FELL ON THE 19th OF FEBRUARY 1962) MEASURED BY γ-RAY SPECTROMETRY. Tobailem, Jacques; Nordemann, Daniel (CEN de Saclay, Gif-sur-Yvette, France). Compt. Rend., Ser. B; 271: 262-4(20 Jul 1970). (In French).

The γ-ray activities of ^{54}Mn, ^{22}Na, ^{60}Co, ^{26}Al, and ^{40}K present in a fragment of 0.805 kg of the Dosso meteorite rock were measured with a γ-ray spectrometer. (tr-auth) (France)

46824 ORGANIC ANALYSIS OF THE PUEBLITO DE ALLENDE METEORITE. Levy, R. L. (McDonnel Douglas Corp., St. Louis); Wolf, C. J.; Grayson, M. A.; Gilbert, J.; Gelphi, E.; Updegrove, W. S.; Zlatkis, A.; Oro, J. Nature (London); 227: 148-50(11 Jul 1970).

Reference is made to the blue-white Type III carbonaceous chondrite which fell in Mexico on Feb. 8, 1969. It is pointed out that most meteorites which have been investigated for the presence of organic compounds had been stored and handled in museums for many years before analysis, leading to a suspicion of terrestrial contamination. At the time of fall of this meteorite, however, various laboratories were preparing for organic analysis of lunar material, using highly refined analytical procedures, and it appears unlikely that the detected organic material could have been introduced by contamination. Details are given of chromatograms from the 460°C pyrolysis of samples, and from stepwise heating, and of organic compounds released. (UK)

Stars

Refer also to abstracts 47006, 47047, and 47101.

46825 ANALYSIS OF MICROWAVE RECOMBINATION LINES. Goldberg, Leo; Cesarsky, Diego (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. Lett.; 6: 93-7 (Aug 1970).

A new method for the analysis of microwave recombination lines of hydrogen is described in which the electron temperature, electron density and emission measure are derived sequentially from observations of α- and higher-order lines. The method is based on the known fact that when the populations of atomic levels are determined by radiative processes and collisional re-shuffling, there is a value of the principal quantum number n, determined by the electron temperature and density, for which the line absorption coefficient is zero, for both α- and higher-order lines. All lines characterized by this value of n are formed as though in a thin layer and according to LTE. (auth)

46826 DAMPING EFFECT OF BETA PROCESSES ON EXPLODING STARS. Barkat, Z.; Buchler, J. R.; Wheeler, J. C. (California Inst. of Tech., Pasadena). Astrophys. Lett.; 6: 117-21(Aug 1970).

In a hot dense plasma ($\rho \gtrsim 10^9$ gm/cm^3, $T \gtrsim 10^9$ °K) such as exists after thermonuclear detonation in a degenerate stellar core, beta processes have a marked effect on the pressure (at $\rho = 5 \times 10^{10}$ gm/cm^3 a 10% pressure drop occurs in about one msec). It is concluded that rapid beta processes could prevent the explosive expansion of a detonated core. (auth)

46827 POLARIZATION MEASUREMENTS OF STARS IN THE MAGELLANIC CLOUDS. Mathewson, D. S.; Ford, V. L. (Australian National Univ., Canberra). Astron. J.; 75: 778-84(Sep 1970).

The results of photoelectric polarization measurements of 215 stars in the Large Magellanic Cloud and 77 stars in the Small Magellanic Cloud are presented. The contribution by the Galaxy to the observed polarization is estimated from polarization observations of 60 galactic foreground stars. Plots of the E vectors of the intrinsic polarization are made on photographs of the two galaxies. (auth)

46828 INFRARED SPECTRA FOR 32 STARS. Johnson, Harold L.; Mendez, Manuel E. (Univ. of Arizona, Tucson. Univ. Nacional de Mexico, Mexico City). Astron. J.; 75: 785-817(Sep 1970).

Infrared spectra of 32 different stars are shown, ranging in spectral type from A0 to M7; also included are spectra of seven carbon stars. The molecules, CO, CN, C_2, CH, TiO, H_2O and, perhaps, AlH were identified in these spectra. A number of atomic lines are visible; foremost among these is the hydrogen line, Brackett γ, which appears in variable emission in most K and M stars. The bands of $^{12}C^{16}O$ are easily separated from those of $^{13}C^{16}O$ and an analysis of their relative strengths indicates a $^{12}C/^{13}C$ ratio of 4 to 5 for most K and M stars, and 10 to 15 for carbon stars. For the S star, χ Cyg, the $^{12}C/^{13}C$ ratio is at least 30. A broad absorption centered at about 3250 cm^{-1} is found in the spectra of the M stars, β Peg and μ Cep; a very similar absorption appears in the spectra of carbon stars. This broad absorption is very similar to that due to H_2O ice. (auth)

46829 PHOTOMETRIC STUDY OF SOME EARLY B STARS WHOSE SPECTRAL LINES VARY IN SHARPNESS. Percy, John R. (Univ. of Toronto). Astron. J.; 75: 818-21(Sep 1970).

Fourteen stars, suspected of being β Cephei stars because of variable spectral-line sharpness, were tested photometrically for short-period light variations. Only three of the stars showed evidence of such variations, and in each case, the range was ≲0.03 m. Two of the stars showed variations on a time scale of several days. (auth)

46830 FOUR-COLOR AND Hβ PHOTOMETRY OF OPEN CLUSTERS. IV. h AND x PERSEI. Crawford, D. L.; Glaspey, J. W.; Perry, C. L. (Kitt Peak National Observatory, Tucson, Ariz.). Astron. J.; 75: 822-30(Sep 1970).

Photoelectric photometry for 68 stars in or quite near to the h and χ Persei cluster nuclei have been obtained with the 36- and 84-inch telescopes at Kitt Peak. Analysis of the data, along with available UBV photometry and MK spectral types, leads to the following conclusions: (i) The interstellar reddening is constant over the field of the cluster nuclei, and is equal to $E(b-y) = 0.41 \pm 0.02$m (one star). This is equivalent to $E(B-V) = 0.59$m. (ii) The ages of the clusters are nearly the same. (iii) The distance to the two clusters is nearly the same (distance modulus difference $\gtrsim 0.1$m). (auth)

46831 RELATIVE PHOTOGRAPHIC POSITIONS AND MAGNITUDE DIFFERENCE OF THE COMPONENTS OF SIRIUS. Lindenblad, Irving W. (Naval Observatory, Washington, D. C.). Astron. J.; 75: 841-7(Sep 1970).

Techniques which permit the resolved components of Sirius to be observed simultaneously, from northern latitudes, by photography and with the precision of any other photographically resolved binary, have been developed for the purposes of astrometry and photometry. A color effect, influencing grating-image separations, has been found which allows a new method of correcting for Ross emulsion contraction. An investigation of the relative positions of the components of Sirius during an interval of four years was carried out. A new value, 9.83 ± 0.05m, was determined for the magnitude difference between the components. (auth)

46832 TRIPLE SYSTEM TAU CYGNI. Heintz, W. D. (Swarthmore Coll., Pa.). Astron. J.; 75: 848-50(Sep 1970).

The parallax of the system and the orbital elements and masses of the inner pair were revised. Some observations of the neighboring variable V 479 Cyg are appended. (auth)

46833 OBSERVATIONS OF THE WAVELENGTH DEPENDENCE OF STELLAR SCINTILLATION. Burke, J. J. (Optical Sciences Center, Tucson, Ariz.). J. Opt. Soc. Amer.; 60: 1262-4(Sep 1970).

Results are presented on an experiment to provide simultaneous running averages of the stellar scintillation in two wavelength bands over identical atmospheric paths. Normalized standard deviations of scintillation in two wavelength bands and the ratios of their log irradiances are tabulated for 35 observations of 5 stars on 17 nights in April 1969. The blue band peaks at 420 nm and is 90 nm wide. The amber band peaks at 550 nm and is 60 nm wide. For stars near the zenith, the blue scintillation is consistently greater than the amber, but the amber scintillation was dominant at larger angles. Zenith angles varied from 14 to 68°. Rays of different color that arrive at the same point in the collecting aperture are separated in the upper atmosphere as they pass through the inhomogeneities causing scintillation. (J.C.W.)

46834 NONISOTROPIC SCATTERING OF LIGHT IN AN ATMOSPHERE OF LARGE OPTICAL THICKNESS. Sobolev, V. V. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 125-9 (Fall 1968).

Translated from Astrofizika; 4: 325-36(1968).

Diffusion of radiation in an atmosphere of large optical thickness and arbitrary scattering indicatrix is discussed. The asymptotic formulas for the reflection and transmission coefficients found earlier are augmented by formulas for the auxiliary functions $\varphi_1(\eta,\tau_0)$ and $\psi_1(\eta,\tau_0)$. The case of an atmosphere of large optical thickness and small true absorption is discussed in particular detail. The corresponding quantities are expressed in terms of similar quantities for a semi-infinite medium with pure scattering. (auth)

46835 PERIOD-LUMINOSITY RELATION FOR CLASSICAL CEPHEIDS. Latyshev, I. N. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 186-90(Fall 1968).

Translated from Astrofizika; 4: 451-60(1968).

The period–luminosity relation $M_V = -1.4 - 2.6 \lg P - 0.2 \lg^2 P$ is established for classical Cepheids. In deriving this result it was assumed that there is an unambiguous relationship between the color and surface brightness of the Cepheids. In contrast to RR Lyrae stars, the emission of Cepheids can be regarded as quasi-stationary. Cepheids with the Blazhko effect may not satisfy this relation. (auth)

46836 RAPID VARIABILITY OF LINES IN THE SPECTRUM OF P CYGNI. Astaf'ev, E. R. (Odessa Astronomical Observatory). Astrophysics (Engl. Transl.); 4: 191-5(Fall 1968).

Translated from Astrofizika; 4: 461-7(1968).

Spectrograms obtained with a dispersion of 1.33 Å/mm at λ4300 Å have shown rapid variations of the H I, He I, Fe III, N II, and O II lines with periods of the order of a day. Variations of the hydrogen lines occur simultaneously, but variations of the lines of other atoms are not synchronous with the hydrogen-line variations. Variations of emission lines do not correspond with variations of absorption lines. (auth)

46837 EVOLUTION OF BINARY SYSTEMS IN THE GALACTIC FIELD. Agekyan, T. A.; Anosova, Zh. P. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 196-8(Fall 1968).

Translated from Astrofizika; 4: 469-74(1968).

The Monte Carlo method was used to investigate the effect of stellar transits on the semimajor axis and eccentricity of binary stars. A determination was made of the frequency with which the decay of a binary and the formation of a new pair are encountered as a function of the velocity of transit of the field star and its impact parameter. The distribution of eccentricities was found for newly formed pairs. (auth)

46838 HOT ISOENTROPIC WHITE DWARFS. Vartanyan, Yu. L. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 145-50(Fall 1968).

Translated from Astrofizika; 4: 373-83(1968).

Hot white dwarfs consisting of iron nuclei and quasi-degenerate electron gas, in which the entropy per unit mass is constant, are discussed. The masses and radii of three series of such configurations are calculated for $s = 0$, $s = 3.77 \times 10^7$, and $s = 4.12 \times 10^7$ erg/deg·g. Both GTR corrections and the neutronization of the nuclei are taken into account. (auth)

46839 SPECTROPHOTOMETRIC INVESTIGATION OF SOME WOLF-RAYET AND OF-TYPE STARS. Kazaryan, M. A.; Vartanyan, K. V. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 46-55(1970). (In Russian).

Spectrophotometric investigation of some Wolf–Rayet and Of type stars in the association around P Cyg was made. The spectrophotometric temperatures and the relative intensities of emission bands of these stars were obtained. The true temperatures of these stars were obtained with the combination of Zanstra's and Ambartzumian's formulae. The optical thicknesses of the shells for L_C radiation, the radius of the twice ionized helium zone, and the electron densities at the bottom of the shells were calculated as well. (auth)

46840 PROPER MOTIONS OF 1160 LATE-TYPE STARS. Olsen, H. J. Fogh (Univ. of Copenhagen, Brorfelde, Denmark). Astron. Astrophys., Suppl. Ser.; 2: 69-95(Jun 1970).

Proper motions and radial velocities are given for 1160 late-type stars observed photoelectrically by Dickow et al. Most of the proper motions are improved GC motions transformed to the FK4 system. (auth)

46841 PHOTOELECTRIC PHOTOMETRY OF 1160 LATE-TYPE STARS. Dickow, P.; Gyldenkerne, K.; Hansen, L.; Jacobsen, P.-U.; Johansen, K. T.; Kjaergaard, P.; Olsen, E. H. (Univ. of Copenhagen Observatory). Astron. Astrophys., Suppl. Ser.; 2: 1-67(Jun 1970).

Photoelectric narrow-band observations were carried out for 1160 late-type stars north of declination –30°. Most of the stars were of spectral type G and K, and a number of high-velocity stars were included in the program. Measured were: the G-band break (index g), the cyanogen absorption with band head at 4216 Å (index n), the break at 4000 Å including the K line of Ca II (index k), the metallic-line index m, and two color indices f and u. The results are presented in a catalogue together with relevant data collected from the literature. (auth)

46842 POLARIZATION OBSERVATIONS OF THE CLUSTERS NGC 129, 225, 581, 663, 744, 869, 884, 957, AND 6882/5. Grigoryan, K. A. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 28-45(1970). (In Russian).

Observations of polarization of the starlight in open clusters NGC 129, 225, 581, 663, 744, 869, 884, 957, and 6882/5 were made with the photoelectric photometer mounted at the Cassegrain focus of the 16 in. and 20 in. telescopes of the Byurakan Observatory. The results are listed and are graphically presented. The ratios of the mean value of polarization to the mean value of visual absorption are given. (auth)

46843 POLARIZATION OBSERVATIONS OF THE CLUSTERS NGC 1342, 1893, AND 2422. Grigoryan, K. A. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 20-7(1970). (In Russian).

Polarimetric observations of the polarization of starlight in open clusters NGC 1342, 1893, and 2422 were made with the 20-inch reflector of the Byurakan Observatory. Polarization of stars in these

clusters was measured with the photoelectric photometer using yellow and blue filters. The results for NGC 1342 and the amounts of polarization in yellow and blue filters for NGC 1893 and NGC 2422 are listed and are presented graphically. The values obtained with yellow and blue filters indicate that there is no wavelength dependence of interstellar polarization in these regions. The ratios of the mean value of polarization to the mean value of visual absorption are P/A (NGC 1342) = 0.022, P/A (NGC 1893) = 0.030, and P/A (NGC 2422) = 0.092. (auth)

46844 POLARIMETRIC OBSERVATIONS OF μ Cep. Grigoryan, K. A. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 13-19(1970). (In Russian)

Polarimetric observations of μ Cep were made on moonless nights from 1965 to 1967 with the photometer mounted at the Cassegrain focus of the 20-inch telescope of the Byurakan Observatory. In each period, observations of μ Cep were made with different filters. The results on μ Cep and standard stars are given. The results for 1965 and 1967 indicate that there is a sharp increase in polarization with increasing wavelength. The values obtained in the period 1966 indicate that there is no wavelength dependence of polarization of μ Cep. (auth)

46845 PROBLEM OF RADIATION TRANSFER IN CONTINUUM. Vardanyan, R. S.; Engibaryan, N. B. (Inst. of Physics, Erevan. Inst. of Mathematics and Mechanical Engineering, Erevan). Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 91-8(1970). (In Russian).

The nonlinear problem of the radiation transfer in plane-parallel layers, when the layers consist of atoms with two energetic levels, basic and ionization, is considered. For solution of the problem, Ambarzumian's method of self-coordinated optical depths is applied. (auth)

46846 IONIZATION IN MOVING ENVELOPES OF LARGE OPTICAL THICKNESS. Terebizh, V. Yu. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 80-90(1970). (In Russian).

The question of the degree of ionization in the moving envelopes of stars, opaque for the frequencies of subordinate continuums, is studied. For this purpose, the diffusion of radiation in a medium, consisting of atoms having three levels, the third level corresponding to the ionized state, is considered. The movement of the medium is taken into account by applying the condition given by Sobolev (1947). The solution of the problem is obtained under the assumption that the stimulated emission and transitions, caused by electron encounters, may be neglected. (auth)

46847 EVALUATIONS OF THE MEAN AGES OF O-B5 STARS BASED ON THEIR DISTRIBUTION IN STELLAR ASSOCIATIONS. Mirzoyan, L. V.; Kazaryan, E. S.; Chavushyan, O. S. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 69-79(1970). (In Russian).

On the basis of the observational material the space distributions of O-B0, B0.5-B1, B1.5-B2, and B2.5-B5 stars in a synthetic stellar association were determined. By means of the obtained data taken with the "hyperbolic" approximation the mean ages of the stars for each of the mentioned intervals of spectral types were evaluated. It was supposed that all stars had been ejected from the nuclei of the expanding stellar associations and that the synthetic association regarding the phenomenon of stellar formation is in a stationary state. The stellar aging function F(r) was used, which actually presents the dependence of the flow of expanding stars of a given spectral type from a distance and determines their aging rates. Taking into account that, according to the observational data, the process of O-B star aging has, in a first approximation, the properties of a statistical process, F(r) is presented by an exponential function. If the velocity of expansion in the association is constant, then the determination of the slope of the linear relation [lg F(r), r], obtained on the basis of the observational data, is equivalent to the evaluation of the mean ages of stars. In fact the mean velocity of expansion increases with the distance from the center of the synthetic association. The evaluation of ages for two cases—of a constant velocity of expansion (k = 1) and of a velocity increasing linearly with the distance (k = 2)—is presented. The observed dependence of the mean ages of O-B5 stars corresponds to the known evaluations of ages obtained by other methods and testifies to the validity of the method. (auth)

46848 SODIUM IN LATE TYPE STARS. Cayrel de Strobel, G.; Chauve-Godard, J.; Hernandez, G.; Vaziaga, M. J. (Inst. d'Astrophysique, Paris). Astron. Astrophys.; 7: 408-31(Sep 1970).

The values already existing in the literature of the abundance of sodium with respect to iron in 128 F, G, and K dwarf and giant stars are critically reviewed. The deficiency in sodium of some halo giants seems to be greater than the deficiency of the iron-peak elements. On the contrary the atmospheres of some young stars when compared to the Sun seem to be richer in sodium with respect to the iron-peak elements which have the same abundance as that of the Sun. Some of the existing observational material has been retreated by means of model atmosphere techniques. (auth)

46849 STATISTICS OF FLARE STARS IN THE SOLAR VICINITY. Arakelyan, M. A. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 56-68(1970). (In Russian).

The luminosity functions of dwarfs with hydrogen emission and flare stars in the solar vicinity are determined. The number of flare stars brighter than $m_v = 17^m$ in some solid angle with its summit in the Sun is estimated provided that the density of these stars is constant up to sufficiently large distances. The comparison of the data obtained with the results of observations shows that an excess of flare stars exists in the solar vicinity. The suggestion is made that this excess is due to members of some stellar association which once existed in the region where at present the Sun is located. (auth)

46850 HYPERON STARS: CAN THEY EXIST IN NATURE. Heintzmann, H.; Hillebrandt, W. (Institut fuer Theoretische Physik, Cologne). Astron. Astrophys.; 7: 443-5 (Sep 1970).

Contrary to current belief there do exist, in general relativity, models for stable hyperon stars, even if one requires that these be neither superluminal nor ultrabaric. With the help of some exact solutions of Einstein's equations and an equation of state for baryon matter proposed recently by Libby and Thomas it is shown that there may be a very small regime of density near 4×10^{17} g cm^{-3} where hyperon stars can exist that are (1) stable against radial pulsations, (2) gravitationally bound, (3) neither superluminal, (4) nor ultrabaric. Upper limits for the number of baryons in such stars are derived also with the help of the exact solution. (auth)

46851 SPECTROSCOPIC STUDY OF THE PECULIAR OBJECT MH$_\alpha$ 328-116. Boyarchuk, A. A. (Crimean Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 109-15 (Summer 1968).

Translated from Astrofizika; 4: 289-301 (1968).

Six 80 Å/mm spectrograms were used to determine the relative emission-line intensities and energy distributions in the continuous spectrum. It was found that the degree of excitation of the emission spectrum in 1966 was lower than in 1965. It is shown that the observations can be explained by assuming that MH$_\alpha$ 328-116 is a double star consisting of an M giant, a hot star with $T = 10^5$ °K, and a nebula with $n_e = 2.5 \cdot 10^6$, $T_e = 18000$°K and $\mathfrak{M} = 1.5 \cdot 10^{-2}\ \mathfrak{M}_\odot$, and that the star MH$_\alpha$ 328-116 belongs to the group of symbiotic stars. (auth)

46852 SPECTROPHOTOMETRY OF F STARS. III. ATMOSPHERE OF σ BOO. Kipper, M. A.; Kipper, T. A. (Inst. of Physics and Astronomy, Tallin). Astrophysics (Engl. Transl.); 4: 116-19(Summer 1968).

Translated from Astrofizika; 4: 303-9(1968).

Results of an analysis of the atmosphere of σ Boö by the method of growth curves are reported. The excitation and ionization temperatures, the microturbulent velocity, the electron pressure, and the relative abundance of the elements are determined. A metal deficiency was found. (auth)

46853 ROTATION AND PULSATIONS OF A GRAVITATING GAS CLOUD. D'yachenko, V. F.; Zel'dovich, Ya. B.; Imshennik, V. S.; Paleichik, V. V. (Inst. of Applied Mathematics, Moscow). Astrophysics (Engl. Transl.); 4: 53-61(Summer 1968).

Translated from Astrofizika; 4: 159-80(1968).

A model of a rotating star with a constant adiabatic exponent equal to the critical value 4/3 is considered. The problem of the axially symmetric adiabatic motion of stellar material is solved numerically for a relatively small initial departure from hydrostatic equilibrium. It is shown that if the total energy is negative then, in contrast to the one-dimensional case, the result is a stable equilibrium state with almost radial pulsations taking place about this state. The frequency of these pulsations is satisfactorily explained by the linear theory of adiabatic stellar pulsations. In the resulting equilibrium state the law of rotation differs substantially from the solid-body rotation. The angular velocity is almost exclusively dependent on the distance from the axis of rotation and decreases in the direction of the surface. A rarefied ellipsoidal envelope surrounding a very dense symmetric core is formed. The model may be useful for the theory of the late stages of stellar evolution, when the adiabatic exponent approaches 4/3 and the conditions for gravitational collapse are created. (auth)

46854 NEUTRON CONFIGURATIONS IN THE GENERALIZED NEWTONIAN THEORY OF GRAVITATION. Saakyan, G. S.;

Mnatsakanyan, M. A. (Erevan State Univ.). Astrophysics (Engl. Transl.); 4: 62-7(Summer 1968).
Translated from Astrofizika; 4: 181-93(1968).

Neutron configurations were calculated using the generalized Newtonian theory of gravitation. The dependence of the mass M and radius R on the central density ρ_0 consists of two branches that are quite different. One of them represents configurations with $M/R < 0.45$ and is not very different from the corresponding curve in the theory with constant k (k is the gravitational "constant"). The second branch represents configurations with $M/R > 0.3$. It corresponds to configurations with any mass. The configurational parameters are unique functions of ρ_0 on each branch. The existence of static superdense configurations with masses of the order of the galactic mass is established. (auth)

46855 EXCITATION WAVE PRODUCED BY A LIGHT FLARE. Abramov, Yu. Yu.; Napartovich, A. P. Astrophysics (Engl. Transl.); 4: 68-72(Summer 1968).
Translated from Astrofizika; 4: 195-206(1968).

The nonstationary problem of resonance radiation transfer in infinite space and in a half space is considered. Asymptotic expressions are found for the density of excited atoms for an arbitrary shape of the absorption line. An analysis is given of the effect of a boundary on the propagation of the excitation wave. The time dependence of the spectral and angular densities of radiation escaping from the medium is discussed. (auth)

46856 THEORY OF DIFFUSION OF RADIATION IN A MEDIUM WITH A MOVING BOUNDARY. Leonov, V. V. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 73-8(Summer 1968).
Translated from Astrofizika; 4: 207-20(1968).

Scattering of light in a homogeneous semi-infinite medium with a moving boundary is discussed. Asymptotic expressions are found for the probabilities of escape and reflection of a photon from the medium. The results are applicable to the theory of novas. (auth)

46857 LIMITING MASS OF HOT SUPERDENSE STABLE CONFIGURATIONS. Bisnovtyi-Kogan, G. S. (Inst. of Applied Mathematics, Moscow). Astrophysics (Engl. Transl.); 4: 79-86(Summer 1968).
Translated from Astrofizika; 4: 221-38(1968).

The limiting mass of hot superdense hydrodynamically stable configurations with constant entropy per unit mass was found. It amounts to about 70 $M_\odot$ and corresponds to a central density of $\rho_c \sim 2 \times 10^{10}$ g/cm^3 and a central temperature of $T_c \sim 7 \times 10^{10}$ °K. The equilibrium chemical composition is analyzed, taking into account iron, neutrons, protons, and ultrarelativistic electron–positron pairs. The exact equilibrium equations of the general theory of relativity are solved in order to obtain a stellar model. The hydrodynamic stability is verified by means of the Chandrasekhar variational principle. It is shown that the limit of thermal stability against neutrino emission is approximately coincident with the limit of hydrodynamic stability. (auth)

46858 STATIONARY AXIALLY SYMMETRIC GRAVITATIONAL FIELDS. Sedrakyan, D. M.; Chubaryan, E. V. (Erevan State Univ.). Astrophysics (Engl. Transl.); 4: 87-93(Summer 1968).
Translated from Astrofizika; 4: 239-55(1968).

Rotation of stellar configurations is analyzed within the framework of Einstein's theory. Einstein's equations are derived for an axially symmetric mass distribution. The angular dependence of the form of the configuration and of the mass distribution appears in the second approximation in the angular velocity. Einstein's equations are written in this approximation, and their analytic solutions are found for empty space. (auth)

46859 STRUCTURE OF A SHOCK WAVE TRAVELING THROUGH A STELLAR ATMOSPHERE. Klimishin, I. A. (L'vov Astronomical Observatory). Astrophysics (Engl. Transl.); 4: 94-100(Summer 1968).
Translated from Astrofizika; 4: 257-72(1968).

An approximate solution is found for the structure of a shock wave both without and with allowance for the radiation pressure and energy density behind the shock front. A method is given for calculating the rapid changes in the parameters across the shock front moving through the gas–radiation mixture, and a nomogram facilitating such calculations is reproduced. (auth)

46860 STUDY OF THE EVOLUTION OF BINARY STARS IN THE GALACTIC FIELD BY THE MONTE CARLO METHOD. Agekyan, T. A.; Primak, N. L. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 120-2(Summer 1968).
Translated from Astrofizika; 4: 311-17(1968).

The result of transits of a field star near a binary star was determined by numerical integration of the equations of motion for the plane problem. Altogether 547 transits were computed for random initial conditions, fixed eccentricities of the binary (e_b = 0.3, 0.6, 0.9), and c = 2, 4, 8 (c is the ratio of the kinetic energy of the field star relative to the binary to the absolute value of the internal energy of the binary). The following quantities were determined: n_1, the number of cases in which the binary was preserved and the field star receded, n_2, the number of cases resulting in the capture by the field star of one of the components of the binary and the recession of the second component, and n_3, the number of decays into three single stars. It was found that n_1/n increased with increasing c. When c = 2 the ratio n_3/n approached 0.5 and then decreased with increasing c. The ratio n_3/n at first increased with increasing c and then decreased. The values of $\bar{u}$, σ_u, $\bar{v}$, σ_v for pairs after interaction are determined. (auth)

46861 INSTABILITIES IN THE ENVELOPE OF THE Be STAR HD 37202 zeta TAU. II. Delplace, A. M. (Observatoire, Meudon, France). Astron. Astrophys.; 7: 459-72(Sep 1970). (In French).

In 1970, 67 radial velocities, profiles, equivalent widths of the lines of the shell star ζ Tauri, and the electron density in the lower layers of hydrogen show a slow pseudo-periodic variation of about 7 years. The pulsation of the envelope is instigated by instability of the inner layers. During every active phase of these layers, fast variations in the radial velocities of the He I, Mg II, and metallic lines are observed and violet satellite lines appear. Changes in the number of visible Balmer lines show that the electron density changes by about a factor 8 in the outer envelope during the 7 year period. At the same time changes in the equivalent widths and profiles of lines of H, Na I, and Ca II indicate a parallel change in density of the material in the outer envelope. The variation of the emission Hα and Hβ profiles is closely connected with the motion of the envelope. The emission Balmer decrement is 3.6. (auth)

46862 THEORETICAL LIGHT CHANGES IN CLOSE BINARIES. Peraiah, A. (Mathematical Inst., Oxford). Astron. Astrophys.; 7: 473-80(Sep 1970).

A general expression for the gravity darkening of the tidally and nonuniformly rotating Roche components of close binary systems is derived. This expression is used to calculate the temperatures and spectral distributions on the surfaces of these components and to compute their luminosities with limb-darkening taken into account. The effects of uniform and nonuniform rotation are considered together with a few cases of synchronous rotation. The distributions, especially that of temperature, are relatively insensitive to the amount of nonuniformity of the rotation. The laws of darkening tend to converge as the mass ratio increases. The results for synchronous rotation of the components are not very different from those found for nonsynchronous systems. Luminosities can be reduced by as much as 40 to 50% of the total luminosities in different directions depending upon the line of sight. (auth)

46863 PHOTOMETRIC INVESTIGATION OF THE STELLAR RING 373. Isserstedt, J.; Schmidt-Kaler, Th. (Ruhr Univ., Bochum, Ger.). Astron. Astrophys.; 7: 481-7(Sep 1970). (In German).

The stellar ring no. 373 (Isserstedt, 1968a) and two extended adjacent star fields were studied by means of photographic and photoelectric photometry. The color–magnitude diagrams V, B–V and V, U–B and the color–color diagram of the stellar ring differ very clearly from the color–magnitude diagram and the color–color diagram of the comparison fields. From these diagrams the reddening $E_{B-V} = 1.01$ m and the distance modulus $m_0 - M = 12.20$ corresponding to a distance of 2.78 kpc was obtained. Using this distance the minor diameter was found to be 7.0 pc in agreement with earlier work. Judging from the photometry the brightest probable member of the ring is presumably of spectral type O and seems to give rise to an additional reddening of 0.2 m, as is often observed for the brightest members of very young stellar aggregates. The brightest members display an uv deficit of unexplained origin. Three bright red stars might be members of the stellar ring. (auth)

46864 ATTEMPT AT RADIO OBSERVATION OF PECULIAR A STARS. Kodaira, K. (California Inst. of Tech., Pasadena); Fomalont, E. B. Contract N00014-67-A-0094-0008. Astrophys. J.; 161: 1169-71(Sep 1970).

Twelve Ap stars were observed with a radio interferometer at 6.2 cm wavelength. An upper limit of radio flux, $S_\nu(6.2\text{ cm}) \lesssim 0.05$ f.u., was found for all of the stars. The absence of radio emission indicates a relatively steady electromagnetic nature for Ap stars. The amount of synchrotron radiation possible cannot produce the variable light and color of these stars. (auth)

46865 TAYLOR INSTABILITIES IN RELATIVISTIC STARS. Schutz, Bernard F. Jr. (California Inst. of Tech., Pasadena). Astrophys. J.; 161: 1173-6(Sep 1970).

Using the relativistic Schwarzschild criterion for the onset of convection, it is shown that the density of total mass–energy inside a spherically symmetric relativistic star must decrease monotonically outward from the center to the surface. Otherwise a Taylor-type instability will develop. (auth)

46866 STATISTICAL ELECTRON–POSITRON EQUILIBRIUM IN A MAGNETIC FIELD. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Contract F19628-70-C-0035. Astrophys. J.; 161: 1177-9(Sep 1970).

A statistical theory of the electron–positron–photon vacuum in the presence of an external magnetic field is given. It is shown that the magnetic field increases the density of the electrons and positrons if the basic quantum of their oscillatory motions of frequency $\omega = |e_+|B/m_+$ is of the order of or larger than the thermal energy, $\hbar\omega \geq kT$. This magnetic activation effect is quantitatively significant at low temperatures. (auth)

46867 ALTERNATIVE TO CONTI'S SPECTROSCOPIC CRITERION FOR THE DETECTION OF METALLIC-LINE STARS. Smith, Myron A. (Steward Observatory, Tucson, Ariz.). Astrophys. J.; 161: 1181-2(Sep 1970).

The ratio Sc II λ4320/Y II λ4309 is suggested for the detection of Am stars. Its advantages over Conti's suggested Sc II λ4246/Sr II λ4215 ratio are that it may be used at a dispersion of 40 Å mm^{-1} and for moderately rotating stars. Correlations with other attributes of Am stars are briefly discussed. (auth)

46868 ATMOSPHERIC BOUNDARIES OF WHITE-DWARF CONVECTION ZONES. Grenfell, T. C.; Boehm, K. H. (Univ. of Washington, Seattle). Astrophys. J.; 161: 1183-6(Sep 1970).

The positions of the upper boundaries of the outer convection zones in white dwarfs with $5000° \leq T_{eff} \leq 14000°K$, $g = 10^8$ cm sec^{-2}, and a chemical composition as determined by Weidemann for van Maanen 2 were calculated. Atmospheric convection is important in all models, but the dependence of the boundary position on effective temperature is very different from that for main-sequence stars. (auth)

46869 RED SUPERGIANTS IN OPEN CLUSTERS. Schild, Rudolph E. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astrophys. J.; 161: 855-66(Sep 1970).

New spectral types and some new UBV photometry are presented for three southern open clusters containing M supergiants, and data for a fourth are rediscussed. It is concluded that the red supergiant near the cluster IC 2944 is probably not a member. The remaining three clusters, which have red supergiants, NGC 3766, NGC 3293, and NGC 4755, have stellar populations similar to that of χ Per. Very young clusters such as h Per, M29, and NGC 6231 apparently do not have red supergiants. It is concluded that most red supergiants are associated with stellar populations of intermediate age ($[10-25] \times 10^6$ years). This conclusion is found to be consistent with the presence of α Ori and α Sco in subgroups of the associations I Ori and II Sco. These results suggest that supergiants up to a mass limit of approximately 16 $\mathfrak{M}_\odot$ spend an appreciable fraction of their helium-burning lifetimes, immediately after helium ignition, as red supergiants, and that neutrino emission dominates the luminosities of supergiants in post-helium-burning stages. (auth)

46870 LUMINOSITY FUNCTION FOR THE GLOBULAR CLUSTER M92. Hartwick, F. D. A. (Univ. of Victoria, B. C.). Astrophys. J.; 161: 845-53(Sep 1970).

The luminosity function for M92 was determined from star counts made in this cluster. Lifetimes in various luminosity intervals were computed by the semiempirical evolution method of Sandage. The results of the analysis are most consistent with the initial helium content of M92 stars being near 35%. (auth)

46871 ELECTRONOGRAPHIC PHOTOMETRY OF STAR CLUSTERS IN THE MAGELLANIC CLOUDS. I. THE COLOR-MAGNITUDE DIAGRAM OF KRON 3. Walker, Merle F. (Cerro Tololo Inter-American Observatory, La Serena, Chile). Astrophys. J.; 161: 835-44(Sep 1970).

Electronographic magnitudes and colors of stars in the cluster Kron 3 in the Small Magellanic Cloud were measured on electrographs taken with a Spectracon image-converter attached to the f/7.5 focus of the 60-inch reflector at Cerro Tololo. On electrographs of 3 hours' exposure, stars as faint as V = 22.46 and B = 22.73 were measured, and the limit of these electrographs was estimated to be about V = 23.2 and B = 23.5. The color–magnitude diagram was derived to about V = 21.6, and consists of a curved giant branch, a short horizontal branch at V = 19.1, and a subgiant branch extending down to the limit of the observations. In a general way, Kron 3 appears to resemble the clusters of intermediate metal abundance or the "metal-rich globular" clusters in our Galaxy, although certain differences remain. The giant branch extends to very red stars, and the fact that the brightest red giants are much less concentrated to the center of the cluster than are the fainter stars suggests that these may be older stars than have lost mass during an earlier passage through the red-giant stage and that have now re-evolved from the horizontal or asymptotic giant branch back into the red-giant region. (auth)

46872 LITHIUM IN HEAVY-METAL RED GIANTS. Boesgaard, Ann Merchant (Univ. of Hawaii, Honolulu). Astrophys. J.; 161: 1003-9(Sep 1970).

Abundance ratios of Li/Ca are determined for seven Ba II stars, five MS stars, and eight S stars from spectrograms with dispersions between 6.7 and 15 Å mm. The Li content of the Ba II stars is similar to that of normal G–K giants. The MS stars and four of the S stars resemble M giants in their Li abundance. Three S stars have 1 to 2 orders of magnitude more Li than typical M stars, but can probably be understood as the descendants of lithium-rich main-sequence stars. T Sgr has more Li than the T Tauri stars. The interpretation of such a large amount of Li is complicated by the presence of strong lines of Tc I which imply that deep convection takes place in this star. (auth)

46873 HALO B STAR HD 137569. Danziger, I. J.; Jura, M. A. (Harvard Coll. Observatory, Cambridge, Mass.). Astrophys. J.; 161: 997-1002(Sep 1970).

A high-dispersion spectral analysis of the halo B star HD 137569 shows that it may have a normal abundance of helium and carbon and certainly a low abundance of magnesium and silicon. It has a low gravity (log g = 2.3) and an effective temperature of 12000°K and may be a highly evolved component of a binary system belonging to Population II. (auth)

46874 MASS EXCHANGE IN BETA LYRAE. Coyne, George V. (Vatican Observatory, Vatican City State). Astrophys. J.; 161: 1011-14(Sep 1970).

New polarimetric observations of β Lyr in six colors show that the polarization observed at primary minimum cannot be due solely to the decrease in the nonpolarized light of the system. An increase in both the electron density and the opacity of the gas, associated with the disk about the secondary component, is suggested to explain the gradient in the visual-to-ultraviolet portion of the polarization curve. This is consistent with the mechanism of mass exchange suggested by Huang to explain the asymmetry in the light curve during primary eclipse. (auth)

46875 ABSOLUTE SPECTRAL ENERGY DISTRIBUTION OF ALPHA LYRAE. Oke, J. B.; Schild, R. E. (California Inst. of Tech., Pasadena). Astrophys. J.; 161: 1015-23(Sep 1970).

The prime-focus photoelectric spectrum scanner and a small telescope 4 inches in diameter were used to make spectrophotometric comparisons between the primary standard star, α Lyr, and several radiation sources to determine the absolute spectral energy distribution of α Lyr from 3300 to 10800 Å. The radiation sources were (1) a tungsten ribbon-filament lamp accurately calibrated at the U. S. National Bureau of Standards, (2) a blackbody cavity operated at the melting point of copper, and (3) a blackbody cavity operated at the melting point of platinum. The spectral energy distribution of α Lyr is shown. The absolute flux from a star of apparent visual magnitude V = 0.00 at 5480 Å is found to be 3.65×10^{-20} erg sec^{-1} cm^{-2} Hz^{-1} or 3.64×10^{-9} erg sec^{-1} cm^{-2} $Å^{-1}$. The accuracy of this figure is estimated to be 2%. (auth)

46876 INTRINSIC POLARIZATION IN CLOSE-BINARY SYSTEMS. Buerger, P. F.; Collins II, G. W. (Ohio State Univ., Columbus). Astrophys. J.; 161: 1025-32(Sep 1970).

A study of the methods by which polarization resulting from Thomson scattering can arise in the distorted atmospheres of the members of close-binary systems is presented. The atmospheres are assumed to be gray, and the distortion caused by axial rotation and gravitational interaction is included. The radiative interaction between the members of the system is also considered, with some simplifying assumptions being made concerning the nature of the incident radiation. A method is presented for calculating the intrinsic polarization to be expected from such a system both in and out of eclipse. Results indicate that polarization varying with phase by up to several tenths of a percent is to be expected. It is therefore suggested that this effect should be taken into account in the discussion of the observed polarization in close-binary systems. (auth)

46877 LIGHT CURVE FOR ECLIPSING STARS WITH SCATTERING ENVELOPES AND ITS APPLICATION TO THE V444 CYGNI BINARY SYSTEM. Huang, Su-shu (Northwestern Univ., Evanston, Ill.). Astrophys. J.; 161: 1033-42(Sep 1970).

The light curve which results from the eclipse of a star by

another star with an absorbing envelope of uniform opacity has been computed. It has then been applied to the observed light curve of V444 Cygni obtained by Kron and Gordon by assuming that an envelope exists around each of the two component stars. With a suitable choice of parameters, the observed points during secondary eclipse match very well with some computed curve. But no single curve can account for the observed data taken during the primary eclipse. Instead, it appears that they shift from one curve to another in a sequence of curves corresponding to different mean opacities—an indication that the envelope around the W star has a density gradient that increases downward. This result is consistent with the phenomenon of mass ejection by the W star. The envelope around the O star is supposed to be formed out of the ejected matter from the W component in the same way that emission rings in some Algol-type binaries are formed out of the ejecta from the less massive component. This suggestion is further strengthened by the fact that the total optical thickness of the envelope associated with the O star is much less than that associated with the W star. Finally, the similarities and differences between this system and β Lyr are discussed. (auth)

46878 COMPUTER SOLUTION OF COMPLETELY ECLIPSING BINARY LIGHT CURVES. Linnell, Albert P.; Proctor, Deanne D. (Michigan State Univ., East Lansing). Astrophys. J.; 161: 1043-57(Sep 1970).

Kopal's iterative method for solving completely eclipsing binary light curves was tested on synthetic light curves. The method converges and recovers known system parameters, including limb darkening coefficients, for simulated observational errors comparable to those obtainable photoelectrically at the telescope. The synthetic-data tests demonstrate the requirement for approximately 300 or more observations in each minimum and in each color and the importance of distributing the observations approximately evenly through each minimum. Application of the method to stars should include solution of a synthetic light curve simulating the actual data as a separate test of convergence properties of the solution. (auth)

46879 ELECTRON CAPTURE IN HIGHLY EVOLVED STARS. Sugimoto, Daiichiro (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 161: 1069-81(Sep 1970).

When a star has evolved to a very high density (about 1×10^9 g cm^{-3}), continuum-electron capture by iron nuclei begins to play a role. Effects of electron capture upon gravitationally contracting iron stars of 1.4 and 2 $M_\odot$ have been investigated. As the electron-capture process is rather slow compared with the dynamical time scale for densities below 10^{11} g cm^{-3}, it can be treated as an endothermic nuclear reaction. Despite the absorption of energy by electron capture, the central temperature of the star is found to increase as the contraction of the star proceeds. For this phenomenon, the accompanying increase in the mean molecular weight is essential. Thus, a significant part of the star is found to enter into a region of temperature high enough for the photodisintegration of iron to occur before the star collapses by rapid electron capture; the photodisintegration commences at the center of a star of 2 $M_\odot$, but in outlying shells of a star of 1.4 $M_\odot$. (auth)

46880 STRUCTURE AND EVOLUTION OF STARS OF VERY LOW MASS. Hoxie, Dwight T. (Univ. of Arizona, Tucson). Astrophys. J.; 161: 1083-99(Sep 1970).

Both an "idealized" and a "detailed" approach are employed to calculate pre-main-sequence evolutionary tracks and main-sequence models for stars of essentially solar composition (X = 0.739, Y = 0.240) in the mass range 0.20 to 0.02 $M_\odot$. The idealized approach is based on the assumption that the interior structure may be represented by a polytrope of index n = 1.5. This assumption is tested through the construction of detailed evolutionary models at 0.1 and 0.07 $M_\odot$ in which the effects due to electrostatic interactions between particles are investigated. The outer boundary condition for both sets of model calculations is obtained from approximate model atmospheres. It is concluded that the polytropic representation for main-sequence objects of very low mass should be adequate and that the lower limiting mass for main-sequence stars is near 0.1 $M_\odot$. Comparison of the main-sequence models with observational data on the masses, radii, and luminosities of low-mass stars in the solar neighborhood reveals considerable discrepancy between the theoretical and the empirical mass-luminosity and mass-radius relations, although fair agreement is found with the adopted empirical mass-luminosity relation for masses below 0.3 $M_\odot$. A possible effect of the main-sequence limiting mass on the observed mass function for nearby stars is discussed. (auth)

46881 RAPIDLY ROTATING STARS. VI. PRE-MAIN-SEQUENCE EVOLUTION OF MASSIVE STARS. Bodenheimer, Peter (Univ. of California, Santa Cruz); Ostriker, Jeremiah P. Contract AF 49(638)-1555. Astrophys. J.; 161: 1101-13(Sep 1970).

The evolution of differentially rotating stars in the range 3 to 12 $M_\odot$ during the radiative portion of the pre-main-sequence contraction is calculated, under the assumptions of axial symmetry, a polytropic (P, ρ)-relation, and conservation of angular momentum. The results show that (1) an increase in the total angular momentum for a given mass has a substantial effect on the evolutionary track, (2) contracting stars which reach the vicinity of the main sequence with calculated surface velocities in the observed range exhibit a considerably different mass-luminosity relation from that of nonrotating stars, (3) models with total angular momenta above a certain critical value may form binary systems by fission before nuclear reactions can stop the contraction, and (4) in these detailed calculations the phenomena known as "equatorial mass loss" or "rotational mass ejection" never occur. Calculated models are compared with observations of rotational velocities in young stars. (auth)

46882 NON-LTE MODEL ATMOSPHERES. VI. LIMB DARKENING AND ROTATION BROADENING OF Hα. Mihalas, Dimitri (Univ. of Chicago); Auer, L. H. Astrophys. J.; 161: 1129-33(Sep 1970).

The center-to-limb variation and rotation broadening of Hα are discussed for LTE and non-LTE atmospheres. The center-to-limb variation is quite different in these two cases; these differences should be measurable by observations of certain eclipsing-binary systems, and such observations could provide a sensitive test of the theory. It is also shown that (a) significant differences exist between rotation-broadened profiles in the LTE and non-LTE cases and (b) Hα may serve as a useful indicator of rotation velocity. (auth)

46883 LIGHT FROM REFLECTION NEBULAE. III. COLOR AT 0° OFFSET. Hanner, Martha S. (Dudley Observatory, Albany, N. Y.); Greenberg, J. Mayo. Astrophys. J.; 161: 961-3(Sep 1970).

The color of reflection nebulae at 0° offset is shown to be dependent on the nebular geometry and the internal extinction. Empirical color data cannot be extrapolated to 0° offset unless a specific nebular model is assumed. (auth)

46884 LIGHT FROM REFLECTION NEBULAE. II. COLORS AND POLARIZATION. Greenberg, J. Mayo; Hanner, Martha S. (Rensselaer Polytechnic Inst., Troy, N. Y.). Astrophys. J.; 161: 947-59(Sep 1970).

The B − V and U − B colors and the B and V polarization in single scattering have been calculated for plane-parallel slab-model reflection nebulae consisting of either dielectric or graphite grains with a variety of geometries. Mie theory has been used to calculate the scattering functions for all spherical particles. Calculations for anisotropic graphite particles are done in the Rayleigh approximation. Models consisting of small graphite spheres and flakes are consistently bluer than models for a size distribution of dielectric grains, $n(a) = n_0 \exp[-5(a/0.5)^3]$, and show a higher degree of polarization. A procedure for interpreting the theoretical nebular colors and polarization in terms of detailed scattering characteristics of the grains is demonstrated. It is shown that, in order to match the color data, the grains must be characterized by strong forward scattering which increases at shorter wavelength. The color variation in the Merope Nebula can be roughly matched by a dielectric-grain model for a star embedded 0.35 pc below the surface of a nebula 1.0 pc thick inclined 10° to the plane of the sky at a distance of 126 pc ($\kappa(5540) = 1.2$ mag pc^{-1}). The best fit to the observed polarization of the Merope Nebula is achieved when the star is well within the nebula and the grains are dielectric. The other grain models give too high a polarization for any geometric configuration. (auth)

46885 SPECTRA OF THIRTY-THREE GASEOUS NEBULAE IN THE YELLOW-GREEN REGION OBTAINED WITH AN ELECTRONIC CAMERA. Aller, Lawrence H. (Univ. of California, Los Angeles); Walker, Merle F. Astrophys. J.; 161: 917-45(Sep 1970).

Observations of thirty-two planetaries and the Orion Nebula, carried out with electronic cameras at the coudé focus of the Lick 120-inch reflector, are described. Advantages of this combination are a large scale and a relatively high speed in the spectral range 4600 to 5900 Å. Throughout much of this range, photographic emulsions are discouragingly slow. A number of astrophysically important lines of He I, He II, C IV, [N I], [N II], O III, [O III], Si II, [Cl III], [Cl IV], [Ar III], [Ca V], [Fe III], [Fe VI], and [Fe VII] fall in this region. The observational results are presented in a series of tables with appended notes. Certain nebulae, notably NGC 6543, NGC 2392, and IC 2003 show striking small-scale changes in excitation, whereas NGC 6720 and possibly NGC

7662 and 7009 tend to show more orderly stratification effects. The [N I] and [N II] lines are found to be especially sensitive indicators of low-excitation regions. Knots of these radiations may be compared to prominences in the solar corona, although it is not established that the [N I] regions have substantially higher densities or lower temperatures. It is concluded that future studies of planetaries must emphasize detailed structural features and the construction of three-dimensional models in addition to their "integrated" properties. (auth)

46886 DETECTION OF 10.5-MICRON LINE EMISSION FROM THE PLANETARY NEBULA NGC 7027. Rank, D. M.; Holtz, J. Z.; Geballe, T. R.; Townes, C. H. (Univ. of California, Berkeley). Astrophys. J.; 161: L185-9(Sep 1970).

Spectra of several planetary nebulae have been obtained, with a resolution of 0.3 cm^{-1}, at 950 and 1112 cm^{-1}, corresponding to the fine-structure transition frequencies from the ground states of S IV and Ar III, respectively. The S IV line has been detected in NGC 7027 at 951.5 cm^{-1}. Detection of the Ar III line in NGC 7027 is also indicated, though not certain. Upper limits for line intensities in other planetary nebulae are given, as well as continuum intensities in these spectral regions. (auth)

46887 RV TAURI STARS: A NEW CLASS OF INFRARED OBJECT. Gehrz, R. D.; Woolf, N. J. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 161: L213-17(Sep 1970).

Large excess 11-μ radiation is reported for three of five RV Tauri stars observed photometrically. It is hypothesized that matter ejected by shock waves condenses to form solids in a cool circumstellar shell about 25 stellar radii in size. (auth)

46888 OBSERVATIONS OF ANOMALOUS RADIATION AT LONG WAVELENGTHS FROM Ic CLASS VARIABLES. Gehrz, R. D.; Ney, E. P.; Strecker, D. W. (Univ. of Minnesota, Minneapolis). Astrophys. J.; 161: L219-23(Sep 1970).

A search for infrared stars associated with OH emission has led to the discovery of anomalous emission at long wavelengths in variables of the class Ic. The long-wavelength anomaly is apparently caused by emission from a circumstellar dust shell. Of the three Ic variables which show no long-wavelength anomaly, two have B companions whose radiation pressure could blow the dust shell away. (auth)

46889 ESTIMATES OF THE γ-RAY FLUX FROM SAGITTARIUS A. Maraschi, Laura; Tarenghi, Massimo; Treves, Aldo (Univ., Milan). Astrophys. Space Sci.; 8: 12-19(Jul 1970).

Analysis of the anisotropy of the γ-ray background observed by Clark et al. (1968) led to the suggestion that part of the anisotropy is due to a source at the galactic center. The complex structure of radio and infrared emission of the region of Sgr A was considered. The γ-ray flux arising from Compton scattering and π^0 decay was calculated. For a value of the magnetic field $H \simeq 10^{-4}$ gauss, corresponding to equipartition, the γ-ray flux above 100 MeV at Earth from the Sgr A source is expected to lie between 10^{-6} and 10^{-5} gamma/cm^2 sec. Such a source should be detectable in the near future. (auth)

46890 ESCAPE OF LIGHT FROM WITHIN A MASSIVE OBJECT. Jaffe, Jack. Mon. Notic. Roy. Astron. Soc.; 149: 395-401(1970).

An analysis was made of the escape of light from within spherically symmetric gravitational masses. It was found that there exist models where a portion of the light emitted inside a star does not escape past the surface; rather, only light within a certain, variable "escape cone" leaves the star. This "escape cone" does not steadily shrink with decreasing radius of emission, unlike the somewhat analogous cone effect for light in an external spherically symmetric field. (auth) (UK)

46891 K-TYPE STARS IN A FIELD NEAR THE SOUTH GALACTIC POLE. Evans, T. Lloyd (Radcliffe Observatory, Pretoria). Mon. Notic. Roy. Astron. Soc.; 149: 311-18(1970).

Spectral types and radial velocities are presented for 31 stars with $B-V > 0.90$ in Pok and Basinski's (1964) catalogue of stars in a field centered on Selected Area 141 near the south galactic pole. Photoelectric UBV observations of 27 stars are given. The interstellar reddening is $E_{B-V} = 0.02 \pm 0.02$ m. Most of the stars are normal giants of types G8-M2; there are 5 subgiants, 2 dwarfs, a weak CN star and an extremely metal poor halo giant. The solar motion and velocity dispersion perpendicular to the galactic plane of the G8-K5 giants are very similar to those of nearby K giants. The relationship of these stars to the A and F stars is discussed. (auth) (UK)

46892 r-PROCESS NUCLEOSYNTHESIS OF ^{12}C SEED NUCLEUS. Ohnishi, Teruaki (Kyoto Univ). Progr. Theor. Phys. (Kyoto); 43: 1480-90(Jun 1970).

The amount of nuclides produced by r-process nucleosynthesis is calculated under the condition of high temperature and high density. In this case the seed nucleus of this process is mainly ^{12}C, which is pumping-out from the equilibrium system, and absorbs enough free neutrons to succeed the rapid-neutron-capture process. The existence of these free neutrons is due to neutronization by the weak interaction at the time of quasi-stational, hydrodynamic contraction of later-stage stars, i.e., presupernovae, and therefore one of the possible astronomical sites of this process is the inner shell of Type-I supernovae. The r-process of ^{12}C seed nucleus can explain the abundance of neutron-rich nuclei in the mass region of $30 \lesssim A \lesssim 250$ except the region of $50 \lesssim A \lesssim 65$. The nuclei belonging to the latter region may be produced by another type of r-process, which may occur under the condition of rather low temperature and low density, and whose seed nuclei may be Fe-group nuclei. (auth)

46893 ANALYSIS OF THE HYADES GIANT STARS ϵ AND γ TAU. Krishna Swamy, K. S. (Rice Univ., Houston, Tex.). Astrophys. Space Sci.; 8: 86-9(Jul 1970).

Two hyades giant stars, ϵ and γ Tau, were studied from an analysis of strong line profiles. Results were: for ϵ Tau, T_e = 4750 K and log g = 2.7; and for γ Tau, T_e = 4700 K and log g = 2.8. Hydrogen-to-metal ratio for the two stars is nearly the same as that of solar value. (auth)

46894 QUANTUM-MECHANICAL CELLULAR METHODS FOR INVESTIGATING THE BEHAVIOR OF MATERIALS UNDER PRESSURE. Barcza, S. (Konkoly Observatory, Budapest). Astrophys. Space Sci.; 8: 102-13(Jul 1970).

Solutions of the Schrödinger equation are presented for hydrogen with the application of various boundary conditions. These solutions have important consequences as regards the high-pressure behavior of materials, i.e., for pressure ionization and for pressure modification of optical features. The results are of some significance in the pressure range of stellar atmospheres or even of laboratory plasmas. The number of bound levels coming into being versus density function was derived and compared with the Inglis-Teller formula. The modification of some oscillator strengths as a function of density was calculated also. (auth)

46895 CONTRIBUTION OF THE DIRECT-TRANSFER MECHANISM TO $^{12}C + ^{12}C$ REACTION. Kozlovsky, Ben-Zion (Tel-Aviv Univ., Israel). Astrophys. Space Sci.; 8: 114-19 (Jul 1970).

The possibility that the $^{12}C + ^{12}C$ reaction proceeds, at low energies (relevant to the carbon-burning phase), via direct transfer of an α particle is investigated. The exact results depend on the precise value of certain spectroscopic factors, which are, as yet, unknown. A few features of the direct transfer mechanism are emphasized, which might be useful in directing attention to cases where direct transfer is of importance for astrophysical reactions. (auth)

46896 SPECTRUM OF A GASEOUS NEBULA OF PURE HYDROGEN. II. Gerola, H. (Univ. of Buenos Aires); Panagia, N. Astrophys. Space Sci.; 8: 120-35(Jul 1970).

Calculations of the optical continuum of a nebula of pure hydrogen were carried out, taking into account, together with the recombination emission, the two-photon emission and the continuous emission in the reaction of formation of the negative ion of hydrogen. It was found that these processes become predominant when thermal collisions are responsible for the excitation of the nebula. Mixed conditions of excitation, that is by both radiation and collisions, were also studied. The optical continuum was found to be very sensitive to the excitation conditions, so that a very small contribution of collisional ionizations to the total number of ionizations is sufficient to sensibly modify the appearance of the continuum. (auth)

46897 COMMENT ON FAR ULTRAVIOLET PHOTOMETRY OF ORION STARS BY G. R. CARRUTHERS. Mihalas, Dimitri (Univ. of Chicago). Astrophys. Space Sci.; 8: 50-2(Jul 1970).

It is shown that the ultraviolet flux deficiency, recently discovered by Carruthers, in early-type supergiants compared to dwarfs of the same spectral type can be explained in terms of the effects of differences in surface-gravity and effective temperature between stars of these two luminosity classes. It thus appears that this deficiency does not represent a serious discrepancy between theory and observation. (auth)

46898 STATIC CRITERION FOR THE STABILITY OF THE EQUILIBRIUM. Calamai, Giulio (Osservatorio Astrofisico di Arcetri, Florence). Astrophys. Space Sci.; 8: 53-8(Jul 1970).

In a previous paper the stability of the equilibrium of an isentropic spherically symmetric relativistic star was related to the

existence inside the configuration of the zeros of a function u. This function, which is a solution of a differential equation, appears there as a pure mathematical tool. Nevertheless, it is susceptible to a physical interpretation, which is drawn out in the present work. This interpretation allows an inquiry into the relation between the above static condition and the well-known dynamic criterion stated by Chandrasekhar and by Misner and Zapolsky on the stability of the equilibrium. (auth)

46899 DIMENSIONS OF GASEOUS RINGS IN CLOSE BINARY SYSTEMS. Plotrowski, S. L. (Univ., Warsaw); Ziolkowski, K. Astrophys. Space Sci.; 8: 66-73(Jul 1970).

The observational data seem to indicate that the upper limit of the dimensions of gaseous rings in close binary systems coincides with the upper boundary of the domain of stability of singly periodic orbits around the component in question. As was shown by Kruszewski, the lower limit is determined by the amount of angular momentum carried by the mass particles ejected near the Lagrangian point L_1 from the surface of the companion. (auth)

46900 STUDY OF THE LONG-TERM BEHAVIOR PATTERNS OF THE VARIATION OF THE EMISSION LINES IN THE SPECTRA OF SOME Be TYPE STARS. Kitchin, C. R. (Univ. of Leicester, Eng.). Astrophys. Space Sci.; 8: 3-11(Jul 1970).

The ratio of the line intensity to that of the nearby continuum for an emission line was derived from objective prism spectra taken at the Norman Lockyer Observatory over the period, 1914 to 1959, for six stars (γ Cassiopeia, ϕ and ψ Persei, HD 20336, 25 Orionis, β Piscium). This was combined with information already in the literature, to study the long-period behavior of the stars. Long-term variations were looked for, and it was found that, with the exception of one of the stars which is a spectroscopic binary, the variations tend to occur in outbursts which may last for 10 to 20 years, and which may show signs of semiregular periodicities during the outburst. It is suggested, that while no stable long-term periodicities were found, the outbursts may recur after long intervals, and that this possibility is demonstrated by one of these stars (γ Cassiopeia). It is also suggested that the semiregular variations that occur during some of the outbursts may be related to an intrinsic cycle connected with the surface of the star, and possibly akin to the solar sunspot cycle. (auth)

46901 QUANTUM THEORETICAL DEDUCTION OF RADIATIVE TRANSFER EQUATIONS IN THE SPECTRAL LINE REGIME. Gelinas, Robert J.; Ott, Ronald L. (Univ. of California, Livermore). Ann. Phys. (N. Y.); 59: 323-74(Aug 1970).

Radiative transfer equations appropriate to low-temperature astrophysical systems, as well as to other radiating systems, are deduced nonphenomenologically from quantum theoretical foundations. Initially, attention is directed to the formulation of a logically consistent theoretical framework in which finite lifetime effects (as manifest by spectral line shapes of nonzero width) emerge systematically into the structure of radiative transfer equations. Subsequently, reductions to the familiar Planck's Law and the Einstein coefficients are viewed in the context of kinetic equations. Nonequilibrium considerations are also briefly discussed. (auth)

46902 RAPID CONTRACTION OF PROTOSTARS TO THE STAGE OF QUASI-HYDROSTATIC EQUILIBRIUM. III. STARS OF 0.05, 1.0, AND 20 $M_\odot$ WITH ENERGY FLOW BY RADIATION AND CONVECTION. Narita, Shinji; Nakano, Takenori; Hayashi, Chushiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 942-64(Apr 1970).

The evolution of collapsing protostars of 0.05, 1, and 20 $M_\odot$ was studied with computations that include radiative as well as convective energy flow. It was found that, when a shock wave that has been generated at the center reaches the outermost layers, the protostars flare up suddenly. The protostar of $1M_\odot$ increases its luminosity from 5×10^{-4} $L_\odot$ to a peak value 6×10^3 $L_\odot$ in a period of the order of 10 days. This peak value depends little on the initial conditions. After the flare-up, a convective region grows inwards from the surface and the luminosity is kept at 1×10^3 $L_\odot$ by convection until the star finally reaches a stage of complete gravitational equilibrium. The luminosity at this stage is found to be very sensitive to the stellar mass, being 8 $L_\odot$ and 5×10^4 $L_\odot$ for the protostars of 0.05 and 20 $M_\odot$, respectively. These computed values of the luminosity are high enough to cover the observations of infrared objects. (auth)

46903 DEVELOPMENT OF THE NOVA OUTBURST IN DQ HERCULIS. Starrfield, Sumner Grosby. Los Angeles; Univ. of California (1969). 173p. University Microfilms Order No. 70-8210.

Thesis.

The hypothesis that the mechanism for the nova outburst is a thermal runaway in the envelope of a white dwarf was confirmed for DQ Herculis. A computer program for the study of short-time-scale phenomena in stellar evolution was developed to study the evolution of a white dwarf envelope. The envelope has a thin layer of hydrogen-rich material overlying a helium-rich core. The observations of DQ Herculis at minimum were examined; they suggest that material is presently being accreted by the white dwarf component. Because of the accretion of material, a shock front is present and is responsible for the observed luminosity and effective temperature of the old nova. The mass accretion rate calculated from the shock front is $10^{-8\pm1}$ $M_\odot$/year. (TSS) (Diss. Abstr.)

46904 SOME REMARKS ON THE ROLE OF NEUTRINO PROCESSES IN RED GIANTS. Chaudhuri, Probhas Ray (Indian Statistical Inst., Calcutta). Can. J. Phys.; 48: 1743-4(15 Jul 1970).

It is shown that the plasma neutrino emission rate, when calculated according to the photon–neutrino weak coupling theory, has significant effects on the evolution of red giants. (auth) (Canada)

Quasi-Stellar, Radio, and X-Ray Sources

Refer also to abstracts 46946 and 47024.

46905 REDSHIFT DISTRIBUTION OF QUASISTELLAR RADIO SOURCES. Petrosian, Vahe (Stanford Univ., Calif.). Astrophys. Lett.; 6: 71-5(Aug 1970).

Extrapolation of the density evolution and the luminosity function, obtained by Schmidt from the data on 3CR quasi-stellar sources, to larger redshifts, indicates a deficiency of observed sources with redshifts larger than 2 in Friedmann models with zero cosmological constant. It is shown that this cannot be due to observational selection effects. It may be caused by fairly rapid changes in the intrinsic properties of sources or in the intergalactic medium at epochs corresponding to this redshift. The cutoff is consistent with Lemaître models without the requirement of such changes. (auth)

46906 OPTICAL SYNCHROTRON RADIATION MODEL FOR ENERGETIC COSMIC EVENTS. Falla, D. F. (University Coll. of Wales, Aberystwyth). Astrophys. Lett.; 6: 77-80 (Aug 1970).

The rapid evolution of the synchrotron power spectrum that occurs for a relativistic electron in a high magnetic field region can give a theoretical radiation continuum of unique form, with $F(\nu) \propto \nu^{-1.0}$. The magnetic fields may be associated with condensations of material in which incident energetic protons interact, producing the electrons through pion decay. A particular version of the model may fulfil several essential requirements for the quasi-stellar objects. The model in its general form may be applied to a wide variety of energetic cosmic events. (auth)

46907 H137β LINE SURVEY OF TWENTY-ONE GALACTIC RADIO SOURCES. Gardner, F. F. (CSIRO, Sydney); Milne, D. K.; Mezger, P. G.; Wilson, T. L. Astrophys. Lett.; 6: 87-91(Aug 1970).

A survey of 21 galactic radio sources was made for H137β line emission at 5005.033 MHz. Most sources were found not to be in local thermodynamic equilibrium. The ratio of the H137β to H109α line profiles showed a strong correlation with the r.m.s. internal turbulence of the source. The LTE electron temperature derived from the H137β line showed a marked dependence on the emission measure of the source. (auth)

46908 FIFTY NEW OH SOURCES ASSOCIATED WITH H II REGIONS. Turner, B. E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. Lett.; 6: 99-108(Aug 1970).

Seventy-one galactic sources, taken mainly from the 11-cm continuum survey of Altenhoff et al. (1970) were searched for OH lines. Twenty-two new sources were observed in emission and 28 in absorption. The fraction showing OH decreases monotonically from galactic longitude 345° to longitude 75°. There is no correlation of apparent opacities with longitude or brightness of continuum source. Although some emission sources may be associated with compact H II regions, others probably are not, and many of the OH absorption sources are associated with small-scale continuum structure as well. (auth)

46909 OPTICAL IDENTIFICATION OF RADIO SOURCES SELECTED FROM THE 4C CATALOGUE. Olsen, E. T. (California Inst. of Tech., Pasadena). Astron. J.; 75: 764-77 (Sep 1970).

A total of 490 radio positions having an average error of ±20 arc sec in both coordinates were studied optically in an attempt to identify the sources. The radio sources were selected from the 4C catalogue and the optical search was carried out on the Palomar Sky Survey prints. Approximately one-third of the 204 identifications proposed are quasi-stellar objects. There is evidence that the plate limit of the sky survey is affecting the identification of galaxies. (auth)

46910 3.8-cm SPECTRUM OF OH: LABORATORY MEASUREMENT AND LOW-NOISE SEARCH IN W3 (OH). Ball, John A. (Harvard Coll. Observatory, Cambridge, Mass.); Dickinson, Dale F.; Gottlieb, Carl A.; Radford, Harrison E. Astron. J.; 75: 762-3(Sep 1970).

A search was made in W3 (OH) for the four emission lines of the $^2\Pi_{\frac{1}{2}}$, $J = \frac{1}{2}$ level of OH based on new laboratory rest frequencies. Within a limiting sensitivity of 0.4 flux unit, no line emission was detected over the velocity range −15 to −95 km/sec. (auth)

46911 SCATTERING OF ELECTROMAGNETIC RADIATION BY TURBULENT PLASMA UNDER COSMIC CONDITIONS. Kaplan, S. A.; Tsytovich, V. N. (Scientific-Research Radio-Physics Inst., Gorky, USSR. Physics Inst., Moscow). Astrophysics (Engl. Transl.); 4: 130-9(Fall 1968).

Translated from Astrofizika; 4: 337-57(1968).

Owing to the nonlinear coalescence and decay of electromagnetic and plasma-turbulence waves, any medium in which plasma turbulence has been excited will give rise to the scattering of radio waves. Such effects have varied astrophysical applications. In this paper the transfer equation is derived with allowance for nonlinear scattering by plasma. Scattering by unstable plasma in which stimulated emission predominates over true absorption is discussed. A simple method for determining the probabilities of coalescence and decay of waves is described, and values of the scattering coefficients obtained by this method are reported. (auth)

46912 POPULATION TYPE OF SOME X-RAY SOURCES. Haupt, W.; Schmidt-Kaler, Th. (Ruhr-Univ., Bochum, Ger.). Astron. Astrophys.; 7: 446-54(Sep 1970). (In German).

Twelve x-ray sources from the publications of Bradt et al. (1968), Giacconi et al. (1967a), and among those the four x-ray sources identified with optical objects, were selected for a survey on sky photographs. This survey was undertaken to find out, whether x-ray sources are connected with conspicuous features of the interstellar matter. This might be possible considering their general correlation to H II regions found by Braes and Hovenier (1966), and Gursky et al. (1967). The survey showed that there are uniquely shaped H II regions (Schmetterling) within the error circles of the given x-ray positions in four cases: GX 5−1, GX 13 + 1, GX 17 + 2, and Cyg X−1. These peculiar H II regions show sharp, more or less elliptically shaped H II and dark filaments extending from the center of the regions outward. Photometric and/or kinematic distances for these H II regions are known or are derived. In one case, GX 3 + 1, the star which has been identified with the x-ray source, is situated exactly on the outer rim of an elliptically ring-shaped H II filament. Positional chance coincidences for these five cases are considered very unlikely. In two cases, Cen X−2 and Sco X−1, the stars identified with these sources also are situated exactly on the outer rim of elliptically ring-shaped dark filaments. In another two cases, GX 9 + 9 and GX 9 + 1, the rims of elliptically ring-shaped dark filaments were found within the error circles of the x-ray positions. In one case, Cyg X−4, the rim of a ring-shaped dark filament is just outside the error box of the x-ray position. Since in those areas of the sky, where the positional coincidences with the ring-shaped dark filaments are found, several dark filaments of this kind are visible, chance coincidences cannot be entirely excluded. A plot of all these objects on the galactic plane shows that they are distributed along the spiral arms. If the positional coincidences between some of the x-ray sources and the ring-shaped clouds are real and represent real physical correlations it might be concluded that these x-ray sources are, as x-ray sources, not older than a few 10^5 years, since the lifetime of regularly ring-shaped clouds will not be more than this. (auth)

46913 CARINA NEBULA AT 6 cm. Gardner, F. F.; Milne, D. K.; Mezger, P. G.; Wilson, T. L. (CSIRO, Sydney). Astron. Astrophys.; 7: 349-58(Sep 1970).

A continuum map was made of the Carina Nebula (NGC 3372) at 5 GHz with a 4′ arc beam. Comparison with lower-frequency data confirms that the radio spectrum is thermal and the nebula optically thin down to 400 MHz. Hydrogen 109α recombination line profiles with 100-kHz resolution were obtained at 19 positions. These are unusually wide and double-peaked in the vicinity of Car II (G 287.6−0.6), the eastern component of the central double. Comparison of radio and optical brightness distribution is complicated by pronounced obscuration. However, Car II coincides with the center of a Hα emission ring some 3′ arc in diameter, while Car I (G 287.4−0.6), the other central peak, coincides with the edge of a well-defined line of absorption. Hydrogen 137β and helium 109α lines were observed in the directions of the two central continuum peaks. The β/α line ratios agree with LTE, and this suggests that electron temperatures derived from recombination lines should be correct. These average around 7000°K and only approach the 10,000°K optical temperatures of Faulkner and Aller (1965) near the outer boundaries of the central region of the nebula, at positions where the absorption is high and no optical data are available. The recombination line velocity profiles near Car II suggest the existence of two ionization fronts with line-of-sight velocities of ±20 km s^{-1} with respect to the mean nebula velocity of −20 km s^{-1}. No satisfactory dynamic model of the nebula was determined. (auth)

46914 RIGHT ASCENSIONS AND FLUX DENSITIES OF 30 RADIO SOURCES AT A FREQUENCY 60 Mhz. Aslanyan, A. M.; Malumyan, V. G.; Sanamyan, V. A. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 9-12(1970). (In Russian).

Right ascensions and flux densities of 30 radio sources at a frequency 60 Mc were measured. Spectra of 13 sources in the range 38 to 412 Mc were investigated. Six of the 7 radio sources identified with radiogalaxies have straight spectra. Three of them are double or multiple radio sources. (auth)

46915 ESTIMATION OF THE ANGULAR DIMENSIONS AND INTENSITIES OF SCINTILLATING COMPONENT OF RADIO SOURCE 3C 161. Panadzhyan, V. G. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 3-8(1970). (In Russian).

The experimental characteristics of scintillations at 60 MHz of the radio source 3C 161 due to interplanetary plasma irregularities are presented. The angular dimensions of the scintillating component of radio source 3C 161 is about 0.3″ and its flux density is 50 flux units at 60 MHz and 60 flux units at 40 MHz. (auth)

46916 SOME MICROWAVE TRANSITIONS FOR MOLECULES CONJECTURED TO BE PRESENT IN COMETS AND IN INTERSTELLAR SPACE. Huebner, W. F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Astron. Astrophys.; 7: 359-66 (Sep 1970). (In German).

Some microwave transitions were investigated for a number of simple molecules composed of the cosmically abundant elements H, C, N, and O. The list of molecules was limited to those for which microwave data are readily available. From an r^{-2} distribution of the density in a cometary atmosphere the sizes of the (at microwave frequencies) optically thick disks, S_1, at heliocentric and geocentric distance of 1 A. U. were calculated. Two temperatures, of 100°K and 200°K, were assumed for the atmosphere, corresponding approximately to the extremes for the gas evaporating from the icy conglomerate nucleus. The high temperatures reached by some dissociation products were not considered. If the abundance of some molecules is at least as high as several percent, then microwave emissions from active "young" comets are on the border of being observable. The largest radius of the "optically" thick disk was obtained for HCN at 100°K: $S_1 = 2.9 \cdot 10^5$ b km, where $b < 1$, is the number fraction of HCN molecules in the total gas. Arguments are presented against the formation of formaldehyde on dust particles through synthesis from simpler molecules in interstellar space. The presence of interstellar CN indicates that one can expect to find interstellar CO. (auth)

46917 ESTIMATION OF THE ANGULAR DIMENSIONS OF SCINTILLATING RADIO SOURCES BY SHIFT OF THE HISTOGRAMS OF SCINTILLATION QUASI PERIODS. Panadzhyan, V. G. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 131-3(1970). (In Russian).

An expression for estimation of the angular dimensions of scintillating radio sources is obtained for the case when interplanetary plasma irregularities may be considered as a thin-phase screen. For a circularly symmetric Gaussian source model, the corresponding expression is $2\theta_0' = 0.175 \sqrt{\bar{T}^2 - \bar{T}_0^2}$, where $\bar{T}$ is the mean quasi period of the radio source under investigation and T_0 that of the point source. (auth)

46918 OPTICAL TIMING OF THE PULSAR NP 0532 IN THE CRAB NEBULA. Nelson, Jerry (Univ. of California, Berkeley); Hills, Richard; Cudaback, David; Wampler, Joseph. Astrophys. J.; 161: L235-44(Sep 1970).

Times of arrival of pulses have been measured for NP 0532 during the period Dec. 15, 1969−May 3, 1970. A good fit could not be obtained to all the data at once, but good fits were obtained after dividing the observing period into four unique intervals. This may indicate sudden events in the pulsar, which produce changes of the order of one part in 10^9 in the pulsar frequency and four parts in 10^5 in the rate of change of frequency. In each case the data imply a slowdown of the pulsar. It was found that

the average value of the "braking parameter" n in the equation $dE/dt = A\omega^n$ was 3.63, but dividing the data into shorter intervals gave values between 0 and 5. (auth)

46919 FLUCTUATIONS IN TIMES OF ARRIVAL OF PULSAR PULSES. Hollweg, Joseph V. (Max-Planck-Institut fuer Physik und Astrophysik, Garching, Ger.). Astrophys. J.; 161: L225-31(Sep 1970).

Recent progress in the interpretation of scintillation and angular broadening of radio sources indicates that the correlation length for electron-density fluctuations in the interplanetary plasma may be four orders of magnitude larger than was earlier supposed. In that case rms fluctuations in the times of arrival of pulsar pulses can be expected to be as large as 10 ms at 75 MHz, if the apparent distance of the pulsar from the solar center is 10 $R_\odot$. Detection of fluctuations in the times of arrival could provide valuable new information about the nature of the solar coronal turbulence, since this effect is sensitive primarily to the longer wavelengths in the turbulence spectrum, in contrast to scintillation and angular broadening, which are sensitive to the shortest wavelengths. (auth)

46920 OBSERVATIONS OF THE $^2\Pi_{\frac{1}{2}}$, J = ½ STATE OF OH. Thacker, D. L.; Wilson, W. J.; Barrett, A. H. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 161: L191-7(Sep 1970).

Observations of the $^2\Pi_{\frac{1}{2}}$, J = ½ excited-state emission of OH were made, which resulted in the first detection of emission from the F = 0 → 1 transition at 4660 MHz in the source Sgr B2. Emission from the F = 1 → 0 transition at 4765 MHz was also detected from the sources Sgr B2 and NGC 6334N. A correlation between the excited-state 4765-MHz and the ground-state 1720-MHz emission was noted that supports the far-infrared/ultraviolet pumping models for Type I OH sources. A search for $^2\Pi_{\frac{1}{2}}$, J = ½ emission was made in thirty-one other OH and H_2O sources, with negative results. (auth)

46921 OBSERVATIONS OF INTERSTELLAR OH AT 4660 MHz. Palmer, Patrick (Univ. of Chicago); Zuckerman, B. Astrophys. J.; 161: L199-201(Sep 1970).

Studies have previously been reported of two of the three allowed transitions in the $^2\Pi_{\frac{1}{2}}$, J = ½ state of interstellar OH: F = 1 → 0 at 4765 MHz and F = 1 → 1 at 4750 MHz. Here observations are reported of the third transition: F = 0 → 1 at 4660 MHz. Emission was probably detected in the source Sgr B2, and upper limits were obtained for nine other sources. (auth)

46922 PRECISE LOCATION OF SAGITTARIUS X-RAY SOURCES WITH A ROCKET-BORNE ROTATING MODULATION COLLIMATOR. Schnopper, H. W.; Bradt, H. V.; Rappaport, S.; Boughan, E.; Burnett, B.; Doxsey, R.; Mayer, W.; Watt, S. (Massachusetts Inst. of Tech., Cambridge). Astrophys. J.; 161: L161-7(Sep 1970).

The celestial positions of four x-ray sources (GX3 + 1, GX5 − 1, GX9 + 1, GX17 + 2) in the Sagittarius region were measured. The experiment was performed with two independent rocket-borne rotating modulation collimators backed with proportional-counter detectors sensitive in the energy range 1.5 to 8 keV. High-precision aspect data were obtained by star photography, which was directly referenced to the collimator grids. (auth)

46923 OPTICAL SEARCH FOR THE X-RAY SOURCES GX3 + 1, GX5 - 1, GX9 + 1, AND GX17 + 2. Kunkel, W. (Cerro Tololo Inter-American Observatory, La Serena, Chile); Osmer, P.; Smith, M.; Hoag, A.; Schroeder, D.; Hiltner, W. A.; Bradt, H.; Rappaport, S.; Schnopper, H. W. Astrophys. J.; 161: L169-72 (Sep 1970).

A search to B = 17 for the optical counterparts of four sources of galactic x rays ($b^{II} < 1.5°$) yielded no clear candidates. The previously reported unusual ultraviolet object in the vicinity of GX3 + 1 was excluded as an optical counterpart of this source by the new, more precise x-ray position. (auth)

46924 SEARCH FOR RADIO EMISSION FROM FOUR X-RAY SOURCES NEAR SAGITTARIUS. Andrew, B. H. (National Research Council, Ottawa); Purton, C. R.; Rappaport, S.; Bradt, H.; Schnopper, H. W. Astrophys. J.; 161: L173-4(Sep 1970).

Upper limits have been placed on the ratios of radio (4.6 cm) to x-ray (4.6 Å) flux densities from four x-ray sources in the region of the galactic center. From these results it is concluded that GX3 + 1, GX5 − 1, GX9 + 1, and GX17 + 2 are markedly different from presently identified supernova remnants. (auth)

46925 X-RAY LINE EMISSION FROM SCORPIUS X-1. Acton, L. W.; Catura, R. C.; Culhane, J. L.; Fisher, P. C. (Lockheed Palo Alto Research Lab., Palo Alto, Calif.). Astrophys. J.; 161: L175-9(Sep 1970).

Observations of the Sco X-1 source with a large-area proportional counter suggest the presence of iron-line emission in the spectrum of the source at an energy of 6.6 ± 0.2 keV. The counts due to the line are in excess of the continuum and background counts by 6 standard deviations. A comparison of the observed line-to-continuum ratio with calculations yields a value consistent with a normal cosmic abundance of iron in the source. (auth)

46926 RESULTS OF SIMULTANEOUS V AND B MONITORING OF SCORPIUS X-1. Mook, Delo E. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 161: 1165-8(Sep 1970).

Results of simultaneous V and B monitoring of Sco X-1 at a time resolution of 80 sec are presented as color−magnitude plots. The data are consistent with a single, linear color−magnitude locus to within the photometric accuracy. (auth)

46927 SCORPIUS XR-1: SOME X-RAY AND OPTICAL OBSERVATIONS (1969 MAY). Burginyon, G. A. (Univ. of California, Livermore); Grader, R. J.; Hill, R. W.; Price, R. E.; Rodrigues, R.; Seward, F. D.; Swift, C. D.; Hiltner, W. A.; Mannery, E. J. Astrophys. J.; 161: 987-95(Sep 1970).

X rays from Sco XR-1 were observed May 17 and 24, 1969. Simultaneous optical observations were carried out at Kitt Peak National Observatory. Data from these two dates are plotted and compared with ten previous rocket observations of Sco XR-1. Optical data were obtained simultaneously during six of these earlier flights. These observations are used to search for a correlation between the varying x-ray and optical emission of this object. (auth)

46928 HIGH-RESOLUTION OBSERVATIONS OF COMPACT RADIO SOURCES AT 13 CENTIMETERS. Kellermann, K. I. (National Radio Astronomy Observatory, Green Bank, W. Va.); Clark, B. G.; Jauncey, D. L.; Cohen, M. H.; Shaffer, D. B.; Moffet, A. T.; Gulkis, S. Astrophys. J.; 161: 803-9(Sep 1970).

Two antennas of the NASA Deep Space Network at Goldstone, California, and Canberra, Australia, have been used as elements of an interferometer. The baseline length is 10592 km, or 81 × 10^6 wavelengths (λ = 13.1 cm). Sources larger than 0.001″ are well resolved. Fifty-six sources show clear interference fringes, which indicate the presence of structure on a scale of 0.001″ or less. Five sources appear to be completely unresolved; seven others probably have a relatively simple structure and are assigned an angular size. The other forty-four have more complex structure. Twenty-four sources are reported as showing no fringes, and a lower limit to their diameter is given. It is estimated that about 15% of the stronger sources at decimeter wavelengths have appreciable structure 0.002″ or smaller in angular size. (auth)

46929 FURTHER MEASUREMENTS OF THE ZEEMAN EFFECT AT 21 CENTIMETERS AND THEIR LIMITATIONS. Verschuur, G. L. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 161: 867-75(Sep 1970).

The results of a third experiment aimed at measuring magnetic fields in interstellar clouds of neutral hydrogen are critically discussed and the results of this experiment and a previous one are extensively analyzed. The effect of different spectral structures on the sidelobes limits the extent to which further observations can be made at low galactic latitudes. (auth)

46930 OBSERVATION OF GALACTIC X-RAY SOURCES NOVEMBER 3, 1968. MacGregor, A.; Seward, F.; Turiel, I. (Univ. of California, Livermore). Astrophys. J.; 161: 979-86 (Sep 1970).

The galactic plane was scanned with a large-area proportional counter that was collimated to 2.5° full width at half-maximum transmission in azimuth. The following x-ray sources were seen clearly above the background in the energy range 1 to 10 keV: Tau XR-1, Sco XR-1, Sco XR-2, Cen XR-3, Nor XR-2/Lup XR-1, Cyg XR-1, Cyg XR-3, Ser XR-1, and Ser XR-2. The x-ray spectra of these sources have been measured and are given in the energy range 2 to 10 keV. The variable source Cen XR-2 was not observed, although the location of this source was scanned. During this observation its intensity was less than one-tenth the intensity of Tau XR-1. (auth)

46931 HEATING OF H I REGIONS BY SOFT X RAYS. II. THE EFFECT OF GALACTIC SOFT X-RAY SOURCES. Werner, Michael W. (Univ. of California, Berkeley); Silk, Joseph; Rees, Martin J. Astrophys. J.; 161: 965-77(Sep 1970).

The possible importance of galactic sources of soft x rays as an alternative to subcosmic rays for heating and ionizing the interstellar medium is investigated. An evaluation is made of the total rate of hydrogen ionization by x rays, including secondary ionizations due to helium recombinations. Difficulties associated with the idea of ionization by subcosmic rays are discussed, and it is shown that the present observations of soft x rays are consistent with several different models of source populations capable

of producing significant ionization and heating. Effects of spatially and temporally nonuniform heating by strong sources of x rays might be observable. The degree of ionization of He (relative to that of H) in H_I regions is shown to be much greater for heating by x rays than for heating by subcosmic rays. However, present data do not permit a distinction between the models of x-ray and of subcosmic-ray heating. (auth)

46932 EXTRAGALACTIC RADIO SOURCES. I. THE INTERPRETATION OF RADIO SOURCE COUNTS. Rowan-Robinson, M. (Queen Mary Coll., London). Mon. Notic. Roy. Astron. Soc.; 149: 365-93(1970).

The dependence of radio source counts on cosmological model and type of evolution was investigated. It was found to be unnecessary to assume any reduction in the number density of radio sources at earlier epochs. Luminosity evolution, rather than density evolution, and cosmological models with low density at the present epoch, are preferred: but the significant differences between cosmological models are reduced by the effect of electron scattering, and the uncertainty in the luminosity function. Density evolution is consistent with the data down to the 5C limit only if there is a luminosity-dependent truncation in the distribution of sources. (auth) (UK)

46933 EVOLUTION FUNCTION AND INTERPRETATION OF RADIO SOURCE COUNTS. Ringenberg, R.; McVittie, G. C. (Univ. of Illinois, Urbana). Mon. Notic. Roy. Astron. Soc.; 149: 341-63(1970).

The theoretical radio source-count formula in a zero-pressure model Universe was solved for the evolution function. The type of evolution considered was differential density evolution. The evolution functions were calculated numerically for a number of models. The theory of the total background radiation, which involves the evolution function, was developed and numerical values were also calculated. (auth) (UK)

46934 SINGLE-PULSE SEARCH FOR PULSARS. Davies, J. G. (Nuffield Radio Astronomy Labs., Jodrell Bank, Eng.); Large, M. I. Mon. Notic. Roy. Astron. Soc.; 149: 301-10(1970).

The Jodrell Bank Mk I telescope was used at 408 MHz to search for pulsars, using an on-line computer to display individual dispersed pulses. The technique is described, and parameters are given for JP 1933 as well as for the three pulsars, JP 1946, JP 2021, and JP 2111, discovered in the search. Some surprisingly large pulses were observed from NP 0532. No evidence of pulsar-like radiation was found in 13 suspected supernova remnants. (auth) (UK)

46935 INTERSTELLAR ABSORPTION OF X RAYS BY PHOTOIONIZATION OF HELIUM AND MOLECULAR HYDROGEN. Brown, Robert Lamme. San Diego, Calif.; Univ. of California (1969). 117p. University Microfilms Order No. 70-8645.

Thesis.

Recognizing cosmic x-ray sources will have their spectra strongly attenuated at energies less than the oxygen K-shell ionization edge primarily through photoionization of helium and hydrogen, the cross sections for these processes were considered in detail. The helium photoionization cross section for the transition $(1s^2)-(1s,\epsilon p)^1P$, in which the residual ion is left in its ground state, was calculated using various bound-state wave functions having one to fourteen parameters. The cross section for simultaneous photoionization and photoexcitation in helium was calculated for states $n \leq 10$ of the residual ion. The helium double photoionization cross section was evaluated, using a more exact representation for the ground state than had been previously employed. The form of the differential cross section was used to motivate an asymptotic calculation and an interpretation of these results is discussed. The sum of the cross sections from double photoionization and from simultaneous photoionization and photoexcitation was found to be 10 to 12% of that from ordinary photoionization. The molecular hydrogen photoionization cross section was calculated making use of the Weinbaum wave function for the bound state and the Born approximation for the ejected electron. A comparison with the available experimental points at high energy is described. The total effective cross section applicable to a cosmic abundance of elements is tabulated and applied to two representative galactic x-ray sources. Strong absorption edges at 0.532 and 0.874 keV are predicted to be present in these sources due to interstellar absorption by oxygen and neon respectively. (Diss. Abstr.)

Solar Phenomena

Refer also to abstracts 46989 and 47101.

46936 SPECTRUM OF TYPE IV BURSTS AT CM AND DM WAVES AND ITS RELATION TO PCA. II. COMPARISON OF SPECTRA OF TYPE IV BURSTS AND PCA. Boehme, Annelies (Deutsche Akademie der Wissenschaften zu Berlin, Tremsdorf, Ger.). Beitr. Geophys.; 78: 283-300(1969).

The maximum intensities of Type IV bursts between 9400 and 600 MHz are compared with the type and maximum absorption of the related PCA. The type and maximum absorption of PCA depends strongly on $I_{max}(3000)$. $I_{max}(600)$ is less suitable to characterize the PCA, especially near the solar center. The maximum adsorption is investigated as a function of $I_{max}(9400)/I_{max}(3000)$ and $I_{max}(600)$, respectively. Furthermore, the type and maximum absorption as a function of the strongly polarized Type IV dm bursts are examined. $I_{max}(3000)$ and $I_{max}(600)$ are investigated as a function of Carrington length. (auth)

46937 CORONAGRAPHIC SOLAR LIMB DATA, MARCH 7, 1970. Fisher, R. R.; Pope, T.; Cain, S. D. (Univ. of Hawaii, Honolulu). Astrophys. Lett.; 6: 109-12(Aug 1970).

Photographic, isodensity, and isophotal data from monochromatic coronagraph observations at 5303 Å and 6563 Å are presented for the eclipse day March 7, 1970. (auth)

46938 SOLAR-FLARE MICROWAVE SPECTRA. Bhatia, V. B.; Tandon, J. N. (Univ. of Delhi). Astrophys. Lett.; 6: 113-15(Aug 1970).

The spectrum of solar-flare microwave bursts is derived on the basis of the coherent plasma emission mechanism for the case $\nu \sim \nu_0 \gg \nu_p$. The derived spectrum bears a good resemblance to the observed spectra, indicating that coherent plasma emission can be a possible source of the flare microwave radiation. (auth)

46939 DISTRIBUTION OF INTERPLANETARY HYDROGEN. Blum, P. W.; Fahr, H. J. (Institut fuer Astrophysik und Exraterrestrische Forschung, Bonn). Astrophys. Lett.; 6: 127-8(Aug 1970).

A distinct anisotropy of the Lyman-α background radiation was detected by the Vela-7 satellite. It is shown that this anisotropy can be explained as scattering of solar Lyman-α by the interplanetary hydrogen. (auth)

46940 RADIO SEARCH FOR FORMALDEHYDE IN COMET BENNETT (1969i). Huebner, Walter F. (Max-Planck-Institut fuer Physik und Astrophysik, Munich); Snyder, Lewis E. Astron. J.; 75: 759-61(Sep 1970).

A search was conducted for the $1_{1,1}-1_{1,0}$ rotational transition of formaldehyde and the H109α recombination line in comet Bennett during its perihelion passage. Probably due to excessive beam dilution, neither one of these lines could be identified with the NRAO 140-ft telescope. (auth)

46941 MAGNETICALLY NONSPLIT LINES IN SUNSPOTS. Stellmacher, G. (Institut d'Astrophysique, Paris); Wiehr, E. Astron. Astrophys.; 7: 432-42(Sep 1970).

Three magnetically nonsplit lines are measured photographically in sunspot umbrae and penumbrae by means of a "spot contrast discriminator," which is described and tested. The origin of parasitic light is investigated in detail, its upper limit is determined by means of a nonsplit Fe^+ line being absent in umbrae. These observational data are compared with calculations for six umbra models and one penumbra model. Concerning the wavelength dependence and the center-to-limb variation of the continuum contrast, the umbra models "Zwaan preliminary," "Wittmann-Schröter," and "Hénoux" are in accordance with the observations. Concerning the profiles of the three nonsplit lines, the models "Zwaan preliminary" and "Hénoux" show a fairly good agreement, which is improved by slight alteration of Hénoux's temperature stratification in the outer layers ($\tau_5 < 1$). From the unchanged nonsplit line Fe λ4065.4 the best agreement between observed and calculated umbral profiles is obtained with a microturbulent velocity $\xi_t^* \lesssim 1$ km/s being of the same order as the photospheric value from recent works. The good agreement between measured and calculated umbral profiles indicates that inhomogeneities are less important for umbrae than for the photosphere. (auth)

46942 [FE II] MAGNETIC DIPOLE TRANSITION PROBABILITIES AND THE PROBLEM OF THE SOLAR IRON ABUNDANCE. Nussbaumer, H.; Swings, J. P. (Univ. of Colorado, Boulder). Astron. Astrophys.; 7: 455-8(Sep 1970).

New calculations for the magnetic dipole transition probabilities of [Fe II] lines, including configuration interaction, lead to a solar iron abundance of $\log N_{Fe} = 7.5$ ($\log N_H = 12.0$). This result agrees with the abundance determined by Grevesse and Swings (1969) on the basis of Garstang's (1962) transition probabilities. It is suggested that λ 7686.32 in Eta Carinae ought to be assigned to $3d^64s^6D_{\frac{9}{2}} - 3d^7\,{}^4P_{\frac{5}{2}}$. (auth)

46943 EFFECT OF THE DENSITY SCALE HEIGHT ON SHOCK-WAVE HEATING IN THE LOW SOLAR CHROMOSPHERE. Jordan, Stuart (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 161: 1189-94(Sep 1970).

The heating of the low solar chromosphere by the shock dissipation of weak hydromagnetic waves was estimated by Osterbrock, who used the van de Hulst model for the low chromosphere. A feature of this model is values for the density scale heights of the order of 200 km. More recent models have scale heights with values generally less than this. When one repeats the solution of Osterbrock's equations for these new models in the case of negligible magnetic fields (of the order of 1 gauss), the resulting shock strength grows so rapidly that the range of applicability of the weak-shock theory is extremely limited. In the case of stronger magnetic fields, other complications arise and the problem cannot be treated in this simple way. The results tend to support the picture of a very rapid transition from the low chromosphere to the corona in regions of weak magnetic-field strength. (auth)

46944 CORRELATION OF X-RAY RADIATION (2-12 A) WITH MICROWAVE RADIATION (10.7 CENTIMETERS) FROM THE NONFLARING SUN. Gibson, Jean; Van Allen, James A. (Univ. of Iowa, Iowa City). Astrophys. J.; 161: 1135-46(Sep 1970).

Absolute values of the x-ray flux in the 2 to 12 Å range, F(2 to 12 Å), from the whole disk of the nonflaring Sun are reported for 734 days during the period July 1, 1966 to Dec. 25, 1968. The data came from equipment on Explorer 33 and Explorer 35. It is found that F(2 to 12 Å) is essentially constant over time periods of the order of 1 day (flares excluded) but varies by a factor as great as 6 over time periods of the order of 1 month. During the entire observing period of about 29 months the flux of the quiet Sun lies between upper and lower bounds of 0.4 and 6.8 milli-ergs $(cm^2\ sec)^{-1}$, respectively, and the monthly minima increase gradually from 0.4 to 1.0 milli-erg $(cm^2\ sec)^{-1}$ as the cycle of solar activity progresses. A correlation study of F and the radio-power density flux P at 10.7 cm (Algonquin Radio Observatory) rejects a linear relationship on both empirical and physical considerations but suggests a relationship of the form $F = a \exp(-b/P)$. A least-squares fit to the observed body of data yields a = 27.3 and b = 385.2, when F is in milli-ergs $(cm^2\ sec)^{-1}$ and P is in units of 10^{-22} W m^{-2} Hz^{-1}. On the basis of a simple, moderately realistic physical model, the foregoing relationship is found to be theoretically plausible for an emitting volume of hot plasma at electron temperature T, optically thin for x rays, and optically thick for radio waves. Inferred temperatures T are in the range $(2.3-6.8) \times 10^6$ °K and volumetric emission measures $\int N_e^2\ dV$ in the range $(7.6-34) \times 10^{48}$ cm^{-3}. Some reservations about the reality of these values are considered. (auth)

46945 NONAXISYMMETRIC CONVECTION IN A ROTATING SPHERICAL SHELL. Durney, B. (National Center for Atmospheric Research, Boulder, Colo.). Astrophys. J.; 161: 1115-27(Sep 1970).

The problem of a rotating, convective spherical shell is considered in the Herring approximation. The relevant equations are integrated in time as an initial-value problem. The main results are: (1) The most unstable modes correspond to convective cells stretching from pole to pole. (2) The calculations of the Reynolds stresses show transport of angular momentum toward the equator. That is, differential rotation sets in with equatorial acceleration. (3) The convective transport of heat is maximum at the equator. This would give rise to an equator–pole difference in flux. (4) If convection is nonaxisymmetric (as in the most unstable modes), then there are no time-independent solutions. The time-dependence is oscillatory and of the form $A \cos(\omega t + m\phi) + B \sin(\omega t + m\phi)$. (auth)

46946 THIN-SCREEN MODEL OF INTERPLANETARY SCINTILLATIONS. Jokipii, J. R. (California Inst. of Tech., Pasadena). Astrophys. J.; 161: 1147-52(Sep 1970).

In the conventional discussions of the thin-screen model of scintillations, the weak-scattering limit is derived under the assumption of a mean-square phase fluctuation much less than unity ($\phi_0^2 \ll 1$). It is found that sufficient conditions for the weak-scattering limit are that (a) the contribution to ϕ_0^2 from fluctuation scales of the order of the Fresnel scale and smaller is much less than unity and (b) the phase-fluctuation spectrum falls off rapidly at large wavenumbers, so that fluctuations with scales smaller than the Fresnel scale squared divided by the correlation length are negligible. It is suggested that, whereas ϕ_0^2 is probably much greater than unity in the solar wind, the above conditions may be satisfied, and the weak-scattering limit may apply at typical radio-frequencies and angular distances from the Sun. (auth)

46947 FARADAY-ROTATION MEASUREMENT OF A 13-CM SIGNAL IN THE SOLAR CORONA. Stelzried, Charles Thomas. Los Angeles; Univ. of Southern California (1969). 198p. University Microfilms Order No. 70-8545.

Thesis.

The goal of this experiment was to further the scientific knowledge of the solar corona by measuring the Faraday rotation of a 2292 Mhz continuous wave signal in this plasma. Pioneer VI was launched into a circumsolar orbit on December 16, 1965, and was occulted by the Sun in the last half of November, 1968. During the occultation period, the 2292 Mhz S-band telemetry carrier underwent Faraday rotation due to the interaction of this signal with the plasma and magnetic field in the solar corona. The NASA/JPL 210-foot diameter antenna at Barstow, California, was used for the measurement. The antenna feed was modified for automatic polarization tracking for this experiment. This modification is described and the performance evaluated. (Diss. Abstr. Int., B)

46948 VARIATIONS IN THE SOLAR ULTRAVIOLET FLUX FROM JULY 13 TO AUGUST 9, 1968. Prag, A. B.; Morse, Fred A. (Aerospace Corp., El Segundo, Calif.). J. Geophys. Res.; 75: 4613-21(1 Sep 1970).

Three simple photodiodes on the Spades satellite (1968 to 059A) have measured the near-Earth solar flux in three broad wavelength intervals: 300 to 1150 A, 1150 to 1600 A, and 1600 to 2100 A. During the first 27 days of the satellite's lifetime, the signals in the two longer wavelength intervals showed nonrandom variations of more than 50% from the mean, and the short wavelength flux varied by 40%. Except for the 1150 to 1600 A channel, the variation did not correlate well with $F_{10.7}$; all three channels showed a much stronger correlation with the area times intensity of calcium plage regions. The data are consistent with a model in which the effective plage temperature is about 1250°K higher than the background sun at all wavelengths in the 300 to 2100 A interval. (auth)

Galaxies

46949 COMPACT COMPONENTS OF THE NUCLEUS OF NGC 1808. Arp, Halton (Carnegie Institution of Washington, D. C. California Inst. of Tech. Pasadena); Berto Francesco. Astrophys. Lett.;65-9(Aug 1970).

Spectra of the nuclear components of the peculiar galaxy NGC 1808 are analyzed. It is concluded that the components are not in dynamical equilibrium and are probably moving outward from the nucleus. (auth)

46950 IONIZATION EQUILIBRIUM OF CARBON IN INTERSTELLAR CLOUDS. Werner, Michael W. (Univ. of California, Berkeley). Astrophys. Lett.; 6: 81-5(Aug 1970).

The variation of the degree of ionization of carbon with position in dense (total hydrogen density $N > 100$ cm^{-3}) interstellar clouds is calculated, including the effects of attenuation of the ionizing ultraviolet radiation by grains and by neutral atoms. It is found that C is mostly ionized throughout clouds with $N < 10^3$ cm^{-3} and largely neutral when $N > 10^4$ cm^{-3}. Since ionization of C is the main source of electrons in dense clouds, these results suggest that NH_3 and H_2CO in interstellar clouds are probably excited by collisions with neutral species. The effects of depletion of C on grains and the cooling effects of C and C^+ fine structure radiation are briefly discussed. (auth)

46951 NUCLEI OF Sc GALAXIES. Iskudaryan, S. G. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 151-62(Fall 1968).

Translated from Astrofizika; 4: 385-408(1968).

A classification based on the Byurakan system is given for 110 Sc galaxies with luminosities equal to or greater than 13m, known radial velocities, and declinations $\geq -20°$. Photometric results for the nuclei of these galaxies are reported. The effect of distance on the Byurakan classification is discussed, and it is shown that, at least up to 70 Mpc, the Byurakan class is relatively independent of distance. The influence of inclination of the galaxies on their class is also discussed. It turns out that this factor has a relatively weak effect on the Byurakan class. Comparison of the Byurakan classes with the morphological types as revised by de Vaucouleurs shows that more galaxies with stellar and starlike nuclei are encountered in the earlier de Vaucouleurs subtypes than class 2 galaxies. The luminosities of the nuclei of Sc galaxies lie between −19.0 and −9.0m. There is some similarity between the morphological and physical characteristics of classes 5 and 2s galaxies. (auth)

46952 POLARIMETRIC STUDIES OF GALACTIC NUCLEI. Dombrovskii, V. A.; Gagen-Torn, V. A. (Leningrad State Univ.). Astrophysics (Engl. Transl.); 4: 163-72(Fall 1968).

Translated from Astrofizika; 4: 409-25(1968).

The results of photoelectric measurements of the polarization of 15 galactic nuclei are reported. For the six Seyfert galaxies NGC 1068, 1275, 3227, 4051, 4151, and 7469, the emission of the nuclei was found to be appreciably polarized. The polarization is explained by the superposition on the usual stellar emission of synchrotron radiation from small sources which do not usually appear in the normal radio range. The polarization of nuclear emission from NGC 598, 7331, and 7814 is probably connected with scattering by dust particles. (auth)

46953 NATURE OF INTERACTING GALAXIES. Zasov, A. V. (Shternberg State Astronomical Inst., USSR). Astrophysics (Engl. Transl.); 4: 173-81(Fall 1968).

Translated from Astrofizika; 4: 427-41(1968).

The statistical analysis of available data on the frequency of occurrence of interacting galaxies is reviewed. It is shown that the spatial density of such systems is proportional to the density of normal galaxies. The interacting systems are most frequently encountered in clusters of spiral galaxies. Interacting galaxies are more frequently encountered in the northern galactic hemisphere than in the southern hemisphere. It is shown that the appearance of interacting galaxies may be related to the presence of a relatively dense intergalactic medium around the galaxies. (auth)

46954 LARGE-SCALE PHOTOGRAPHS OF SOME MARKARYAN GALAXIES. Kalloglyan, A. T. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 199(Fall 1968).

Translated from Astrofizika; 4: 475-6(1968).

Reproductions of galaxies 9, 22, 49, 53, 69, and the core of 10, as listed by Markaryan (1967), are given. The morphological properties of these galaxies are described. (W.D.M.)

46955 COLD NEUTRAL HYDROGEN IN THE TAURUS DUST CLOUDS. Sancisi, R.; Wesselius, P. R. (Sterrenkundig Laboratorium Kapteyn, Groningen, Netherlands). Astron. Astrophys.; 7: 341-48(Sep 1970).

The existence of large amounts of cold neutral atomic hydrogen in the Taurus dust clouds is suggested as a plausible explanation of observational results in the 21-cm line and as an alternative to the presence of large quantities of molecular hydrogen. In the direction of these dark nebulae hydrogen-line emission profiles obtained with the 25-metre radiotelescope at Dwingeloo show two dips at the radial velocities +6 and +2 km/s. It is possible that these dips are caused by the presence of cool hydrogen which is associated with the dust. The cool H I may lie either in front of a hot background, or be embedded in a layer of gas clouds. Upper limits of about 75°K and 32°K are found for the spin temperatures, and lower limits of 0.2 and 0.5 are found for the optical depths of the gas causing the dips at +6 km/s and at +2 km/s. (auth)

46956 STATISTICS OF INTERACTING GALAXIES. Karachentsev, I. D.; Terebizh, V. Yu. (Byurakan Astrophysical Observatory, USSR). Astrophysics (Engl. Transl.); 4: 182-5(Fall 1968).

Translated from Astrofizika; 4: 443-9(1968).

Data on the spatial distribution of interacting galaxies brighter than 15.0 m are discussed. Statistical analysis has shown that the processes leading to the formation of interacting galaxies are due to internal factors. (auth)

46957 FISSION PROCESSES AND NONSTATIONARITY OF SYSTEMS OF GALAXIES. Karachentsev, I. D.; Terebizh, V. Yu. Soobshch. Byurakan. Observ., Akad. Nauk Arm. SSR; 41: 99-130 (1970). (In Russian).

The role of the fission of galactic nuclei in the dynamical evolution of systems of galaxies is investigated. As a first step, the reproduction model described by a point branching stochastic processes is studied. A rigorous solution of the problem is obtained and a number of consequences are compared with observational data. The existence of nonstationarity of systems of galaxies possessing a positive total energy is naturally explained in the framework of the model suggested. It is shown that the calculated characteristics of systems of galaxies such as the radius, the density of population, the velocity dispersion, quota of crowded double galaxies, and some others reconcile with observational ones. (auth)

46958 SECOND SUPERNOVA IN NGC 2276. Shakhbazyan, R. K. (Byurakan Astrophysical Observatory, Erevan). Astrophysics (Engl. Transl.); 4: 123-4(Summer 1968).

Translated from Astrofizika; 4: 319-21(1968).

On a photograph of NGC 2276, obtained in yellow light with a 40-inch Schmidt telescope during the night of Jan. 26-27, 1968, a bright starlike object having a magnitude of 15.7 was found, which subsequently proved to be a supernova. The light curve is given along with before-and-after photographs. (W.D.M.)

46959 STATISTICS OF SUPERASSOCIATIONS IN DISTANT GALAXIES. Shakhbazyan, R. K. (Byurakan Astrophysical Observatory, Erevan). Astrophysics (Engl. Transl.); 4: 101-8 (Summer 1968).

Translated from Astrofizika; 4: 273-88(1968).

A study of 84 Sc, SBc, and Irr galaxies, which form a homogeneous set, has shown that 15 of the galaxies possess superassociations. The total number of superassociations is 38. The sizes, coordinates, and preliminary visual estimates of the luminosities of bright condensations found on the plates are reported. In addition, data are given for 24 superassociations observed in seven galaxies but not included in the statistics. The dependence of the frequency of appearance of superassociations on luminosity, Byurakan class, and other galactic parameters is considered. (auth)

46960 FORBIDDEN EMISSION LINES OF IRON IN SEYFERT GALAXIES. Nussbaumer, H. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.); Osterbrock, D. E. Astrophys. J.; 161: 811-20(Sep 1970).

The excitation of the [Fe VII], [Fe X], and [Fe XIV] emission lines in Seyfert galaxies is discussed, with special reference to the interpretation of the strengths of these lines in NGC 4151. The [Fe VII] lines probably arise in the same regions as the [Ne V] lines. Newly calculated collision strengths for [Fe VII] are presented, and they are used to find the relative Fe abundance in NGC 4151, approximately $N(Fe)/N(H) = 1.4 \times 10^{-5}$, with an uncertainty of approximately a factor of 2. The [Fe X] and [Fe XIV] lines may arise in a high-temperature gas, as Oke and Sargent suggested. On this model the amount of high-temperature gas is calculated by using published collision strengths for [Fe XIV] and published plus estimated collision strengths for [Fe X]. The radiation from this high-temperature gas, if it exists, is energetically sufficient to photoionize much of the "cool" gas in which the other observed emission lines are emitted. Thus the hot gas may be the primary source of photoionization. It may be heated by collisions between clouds moving with velocities corresponding to the observed line widths. (auth)

46961 GASEOUS COMPONENT OF THE PECULIAR GALAXY NGC 5253. Welch, Gary A. (Univ. of Washington, Seattle). Astrophys. J.; 161: 821-33(Sep 1970).

Results are reported of an extensive investigation of the galaxy NGC 5253. The absolute magnitude and mass are estimated and are found to compare closely with those of NGC 205 and M32 of the Local Group. The distance modulus is approximately 26.8. NGC 5253 does not closely resemble a Seyfert galaxy as was suggested in a preliminary study. The distribution of stellar surface brightness and the lack of resolution appear to mimic an elliptical system. However, complex structure near the center argues against the existence of a relaxed stellar component there. Furthermore, ionized gas is found throughout the central region out to distances of 15 to 20″—a considerable fraction of the entire galaxy is enhanced by emission. The condition of the gas more closely resembles that of galactic H II regions than of planetary nebulae or Seyfert nuclei. About 10^4 BO V stars or 10^5 hot horizontal-branch stars are needed to produce the nebular emission. An abnormally high N/O abundance ratio in the gas suggests that stellar evolutionary processes have enriched it. A model of the emission nebula indicates that the mass ratio (H II)/(total) is roughly 0.003, and the ratio (H I)/(total) may be 10 times as large. Thus the gas content far exceeds that in ordinary ellipticals, and in fact is on the same order as that of the Magellanic Clouds. (auth)

46962 NUMERICAL EXPERIMENTS ON SPIRAL STRUCTURE. Miller, R. H. (Univ. of Chicago); Prendergast, K. H.; Quirk, William J. Contract AT(11-1)-614. Astrophys. J.; 161: 903-16(Sep 1970).

Spiral patterns that survive for about three "galactic rotations" were obtained with the computer model of a self-gravitating system recently described. These patterns were obtained in the "gas" component of a system that consisted of "gas" and "stars," with "stars" being created out of the "gas" in a manner reminiscent of the natural processes in galaxies. The importance of computer models displaying persistent spiral patterns is that they may be used for experiments to see how various modifications affect the persistence or appearance of the spiral patterns. Several experiments were carried out to determine the roles of the constituent parts of the system. Spiral patterns in the "gas" component appear to be driven by asymmetries in the stellar background. (auth)

46963 APPLICATION OF THE DENSITY-WAVE THEORY TO THE SPIRAL STRUCTURE OF THE MILKY WAY SYSTEM.

III. MAGNETIC FIELD: LARGE-SCALE HYDROMAGNETIC SHOCK FORMATION. Roberts, William W. Jr. (Univ. of Virginia, Charlottesville); Yuan, C. Astrophys. J.; 161: 887-902(Sep 1970).

A theoretical model of the magnetic field of the Galaxy based on the density-wave theory is proposed. In the coordinate system rotating at the pattern speed of our Galaxy, the magnetic line of force and the streamline of the interstellar gas are parallel to each other, and both of them form closed circuits. The difficulty of the winding up of an arm and the continual stretching of magnetic lines of force is completely avoided. Both the linear analysis and the nonlinear analysis of the hydromagnetics are carried out. It is found that the magnetic field inside the arm is nearly parallel to the direction of the galactic spiral, and the strength there is of the order of 5 microgauss, which corresponds to a mean field strength of about 2 to 3 microgauss in the base state. Large-scale hydromagnetic shock waves are found to be possible in the nonlinear gas-flow picture and are suggested as the triggering mechanism for star formation in narrow spiral strips lying along a grand design of spiral structure. The compatibility of a two-armed spiral shock pattern with magnetic field is confirmed. The results are found to be in good agreement with observational studies. (auth)

46964 RECOMBINATION LINES FROM TWO EXTENDED SOURCES IN THE DIRECTION OF THE GALACTIC CENTER. Roberts, Morton S.; Lockman, Felix J. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astrophys. J.; 161: 877-85(Sep 1970).

Four recombination lines from hydrogen: 156a, 166a, 167a, 168a, were detected from the direction of the galactic center. The line profile is made up of two components: one at a velocity of +4 km s^{-1} and the other at −57 km s^{-1}; both are with respect to the local standard of rest. This line radiation originates from a spatially extended source or sources. The ratio of the peak antenna temperatures of these two velocity features varies with the principal quantum number, a fact which implies two physically different regions. At 166a the peak antenna temperatures are 0.65°K for the +4 km s^{-1} feature and 0.30°K for the −57 km s^{-1} feature. Comparisons with the H I absorption spectra toward Sgr A are discussed and a spatial coincidence for the recombination-line regions with the 0 and −53 km s^{-1} neutral-hydrogen features is suggested, although the possibility of their origin from H II regions in the galactic center cannot be rejected. (auth)

46965 RELAXATION TIMES FOR CLUSTERS OF GALAXIES. Noonan, Thomas W. (Brockport State Coll., N. Y.). Astrophys. J.; 161: 1195-6(Sep 1970).

The tendency for the relaxation times of compact clusters to exceed those of medium-compact clusters is noted and discussed. (auth)

46966 POSSIBLE CAUSE OF SOME UNIDENTIFIED INTERSTELLAR ABSORPTION BANDS: CRYSTAL-FIELD ABSORPTION BANDS DUE TO Fe^{3+}. Huffman, Donald R. (Univ. of Arizona, Tucson). Astrophys. J.; 161: 1157-9(Sep 1970).

Optical absorption bands expected in γ-Fe_2O_3 due to Fe^{3+} ions in the crystal lattice are shown to match closely in position, width, and strength with diffuse interstellar bands at 4430, 4760, and 4890 Å. (auth)

46967 X-RAY EMISSION FROM SUPERNOVA OUTBURSTS AND THE DIFFUSE X-RAY BACKGROUND. Tucker, Wallace H. (American Science and Engineering, Cambridge, Mass.). Contract F44620-67-C-0065. Astrophys. J.; 161: 1161-3 (Sep 1970).

It is suggested that the x-ray emission produced during the early phases of a supernova outburst might be sufficient to account for the diffuse x-ray background. If $\sim 3 \times 10^{50}$ ergs in x rays are emitted over a period of a few days or longer, and if events of this type occur once every hundred years in normal galaxies, then both the isotropy and power requirements can be satisfied. It should be possible either to prove or to disprove this hypothesis by means of x-ray observations from satellites in the next year or so. (auth)

46968 STUDY OF GAMMA RAYS FROM THE REGION OF THE GALACTIC CENTER. Kniffen, D. A.; Fichtel, C. E. (Goddard Space Flight Center, Greenbelt, Md.). Astrophys. J.; 161: L157-60(Sep 1970).

Results from a high-altitude balloon flight of a large digitized spark-chamber γ-ray telescope confirmed the existence of γ radiation from the region of the galactic center. The number of γ rays observed in the interval defined by $-6° \leq b^{II} \leq +6°$ and $-39° \leq l^{II} \leq +24°$ was 4.3 standard deviations above that expected from atmospheric background. The average line intensity derived from the data was $(2.0 \pm 0.7) \times 10^{-4}$ $(cm^2 \text{ rad sec})^{-1}$ for $E_\gamma > 100$ MeV. A preliminary determination of the ratio of the intensities above 50 MeV and 100 MeV indicates that the celestial γ rays from the region of the galactic center have a flat energy spectrum, consistent with that expected from π^0-decay. (auth)

46969 INFRARED VARIABILITY OF THE SEYFERT GALAXY NGC 1068. Pacholczyk, A. G. (Univ. of Arizona, Tucson). Astrophys. J.; 161: L207-11(Sep 1970).

Observations of NGC 1068 at 2.2 μ indicate variability with a time scale of a few days, implying that the size of the infrared-emitting region is not larger than a few times 10^{15} cm. This limit on size is incompatible with the interpretation of infrared radiation by remission from dust grains, by synchrotron emission in a uniform model, and by synchrotron emission from many compact sources within the same object ("irtrons"). The infrared observations of NGC 1068 could be explained in terms of a non-uniform, spherically symmetric, synchrotron source with a radial dependence of the flux and of the frequency at which the source becomes optically thick. (auth)

46970 INFRARED OBSERVATIONS OF GALAXIES AND OF THE EXTENDED NUCLEUS IN M82. Kleinmann, D. E. (Rice Univ., Houston, Tex.); Low, F. J. Astrophys. J.; 161: L203-6 (Sep 1970).

The 10-μ source at the center of M82 extends 25″ along the plane of the galaxy and 8″ toward its poles. NGC 3227, NGC 4736, and NGC 5195 are bright at 10 μ; thus, fourteen galaxies are now known to emit most of their luminosity in the far-infrared. (auth)

46971 MARINER 6 MEASUREMENTS OF THE LYMAN-ALPHA SKY BACKGROUND. Barth, Charles A. (Univ. of Colorado, Boulder). Astrophys. J.; 161: L181-4(Sep 1970).

The Mariner 6 ultraviolet spectrometer measured the La sky background while in interplanetary flight, and it was found that the most intense region was concentrated not along the galactic equator nor in H II regions, but in Ophiuchus where the measured intensity is 4.9×10^{-4} ergs cm^{-2} sec^{-1} $sterad^{-1}$. (auth)

46972 EVOLUTION OF GALAXIES AND SECULAR VARIATION OF COSMIC RAYS, MAGNETIC FIELDS, AND TURBULENCE. Matsuda, Takuya (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 1491-1510(Jun 1970).

Numerical computations of evolution of galaxies were made on the assumption that the galaxies are a homogeneous mixture of gas and stars with constant volume and that the stellar birth rate depends not only on the density but also on the temperature of gas in the galaxies. Evolutional changes of the luminosity, the mass of gas, the temperature, the chemical composition and energy densities of cosmic rays, magnetic fields, turbulence, radiation fields and thermal energy were calculated. The results show that the time variation of these quantities is rather small because negative feedback operates. The luminosities change a factor of ten and a factor of two in the case of elliptical galaxies and spiral galaxies, respectively. The energy densities of cosmic rays, magnetic fields, and turbulence were found to be nearly equal and about 10^{-12} erg cm^{-3}, and the energy densities of radiation fields were also about 10^{-12} erg cm^{-3} at the time 10^{10} years. This result agrees well with observations. Model galaxies with various initial densities of gas were examined, and it was concluded that the Hubble types of galaxies are not in evolutional sequence but the initial gas density determines the types of galaxies, as was suggested by Holmberg. (auth)

46973 OBSERVATIONS OF M87 AT 5 GHz. Graham, Ian (Mullard Radio Astronomy Observatory, Cambridge, Eng.). Mon. Nctic. Roy. Astron. Soc.; 149: 319-39(1970).

M87 (Virgo A, 3C274) was observed at 5 GHz with the Cambridge One-Mile telescope, with a resolution of 6.5″ × 28″ arc. These observations did not include the extensive halo, but showed that the central region of the source consists of at least three components. The central component is unresolved and appears to coincide with the optical nucleus; the outer pair extend from a point about 10″ arc south of the optical nucleus. These components are unresolved perpendicular to their extension axes. The north preceding component is related to the optical jet, but is more extended. The physical conditions in the radio components and the optical jet were investigated in the light of these new observations. It was concluded that the two outer components probably consist of a number of small subcomponents, each confined by its supersonic passage through the gas in the galaxy. It is shown that the nuclear component probably has two subcomponents, the smaller of these possibly producing the observed x rays by the inverse

Compton effect. The structure of the halo is used to derive some information about the past activity of the source. (auth) (UK)

46974 GASEOUS COMPONENT OF THE PECULIAR GALAXY NGC 5253. Welch, Gary Alan. Seattle, Univ. of Washington (1969). 208p. University Microfilms Order No. 70-8506. Thesis.

Results are reported of an extensive investigation, directed primarily at the emission component, of the peculiar galaxy NGC 5253. A crude distance estimate gives a modulus of ~26.8 and $M_V \approx -16.4$. Using $\mathfrak{M}/L = 10$ implies a mass of $\sim 3 \times 10^9$ $M_\odot$. It is not a Seyfert galaxy, as was suggested by a preliminary study. The electron temperature of the ionized gas is found to be 12,500°K in high-excitation regions and ~4000°K in areas of low excitation. Conflicting density measurements obtained from the Hβ surface brightness and the ratio of the [O II] doublet lines are reconciled by a model where the ionized gas occupies only about six percent of the available volume. Radiative ionization can probably best explain the observed Balmer decrement and must be invoked to produce the ionic line strengths of oxygen. About 10^4 BOV stars are needed to meet the energy requirement of the nebula. The observed gas velocities in NGC 5253 are 50 to 100 km/sec. The velocity field cannot be explained by pure rotation and it is proposed that south of the nucleus inward and/or outward streaming is in progress. Although the suggested hot star population provides ultraviolet energy sufficient to account for the streaming it is currently thought that such stars can accelerate surrounding neutral hydrogen only to velocities ≲10 km/sec. A simple model of the mean distribution of ionized gas is constructed from observed surface brightness profiles of Hα. The mass of H II implied by the model within a sphere of radius ~300 pc centered on the nucleus is $\sim 10^7$ $M_\odot$ or almost one percent of the total mass of the galaxy. The existence of neutral oxygen in the nucleus shows that considerably more neutral gas is present. In fact if similar conditions exist everywhere within the model nebula then the H I mass must be on the order of 10^8 $M_\odot$. The presence of such large amounts of gas in a system showing a relaxed star population is without precedent. The ratio N(He)/N(H) in the gas was found to be ~0.14, a value not significantly different than for objects in our galaxy. On the other hand nitrogen appears overabundant with respect to oxygen by a factor between 4 and 10 which can be explained by supposing that much of the gas has been ejected by evolving stars. If this suggestion is correct then stellar evolutionary mass loss in NGC 5253 has taken place on a scale much greater, relative to the total mass of the galaxy, than in any other known system. (Diss. Abstr.)

Cosmology

46975 CLASSICAL CHARGED PHOTON. Dolan, P. (Imperial Coll. of Science and Tech., London). Nature (London); 227: 825-6(22 Aug 1970).

Reference is made to Bonnor (Nature 225:932) (1970); Internat. J. Theoret. Phys. 2: 373(1969)), who gave a solution of Maxwell's equations which can be interpreted as a radiative field caused by a source moving at the speed of light. In the present communication it is shown that in Minkowski space, for a null or radiative solution of Maxwell's equations satisfying Bonnor's conditions, the radiation is propagated along a family of null straight lines that is, in general, shear free, expanding, and twisting. In the absence of twisting the scalar field in these solutions vanishes at every point of the null curve. Bonnor's rather strange solution arises as the singular solution of an equation that gives zero expansion and twist. Radiation problems in space-times are discussed in terms of tetrads of null-vectors, and linear differential operators are employed. It is shown that the radiation field propagates along shear-free null geodesics. (UK)

46976 NONEXISTENCE OF STATIONARY INFINITE NEWTONIAN UNIVERSES AND A MULTI-DIMENSIONAL MODEL OF SHOT NOISE. Daley, D. J. (Cambridge Univ., Eng.). Nature (London); 227: 935(29 Aug 1970).

Holtsmark (Ann. Phys. 58: 577 (1919)), in an electrostatic context, and Chandrasekhar (Rev. Mod. Phys. 15: 1 (1943)), in the case of a Newtonian gravitational field, gave a simple model describing the electrostatic or gravitational field at an arbitrary point in space. It is pointed out that if this model is to be at all realistic it must have the property of stationarity. Mathematical analysis, however, shows that this is not so. The model proposed is a special case of a generalization of shot noise in which points are scattered homogeneously and randomly, as a Poisson process, in an n-dimensional Euclidean space. (UK)

46977 SCATTERING OF GRAVITATIONAL RADIATION BY A SCHWARZSCHILD BLACK HOLE. Vishveshwara, C. V. (New York Univ.). Nature (London); 227: 936-8(29 Aug 1970).

The belief that pulsars are neutron stars resulting from gravitational collapse has strengthened the belief in the possible presence of Schwarzschild "black holes" or "horizons" in nature, these being the ultimate stage in the progressive spherical collapse of a massive star, and the stability of which ensure their continued existence. Such an "horizon," however, is stated to be elusive and intriguing, and it is interesting to explore theoretically all possible modes in which the presence of such a "black hole" manifests itself. A summary of some results obtained from an investigation of the scattering of gravitational waves by a Schwarzschild horizon is presented. A spherically symmetric mass distribution is assumed to have collapsed into a Schwarzschild surface in the infinitely remote past, and the scattering of gravitational waves by this configuration can be examined employing perturbation techniques. It is found that the scattering problem is formally the same as that encountered in quantum mechanics for a one-dimensional potential barrier. Attention is confined to results concerning the scattering of odd parity gravitational waves of angular momentum l = 2 by a Schwarzschild "black hole." (UK)

46978 GEOPHYSICS AND COSMOLOGY. Treder, Hans-Juergen (Deutsche Akademie der Wissenschaften zu Berlin, Babelsberg, Ger.). Beitr. Geophys.; 78: 1-26(1969). (In German).

Two types of connections between cosmology and geophysics are existent. Firstly, any fundamental law of physics is incomplete without reference to initial and boundary conditions. That is the case for laboratory physics and for any part of cosmic physics a fortiori. The new ideas in cosmology, relativity, and unitary field theory show strong connections between the laws of the elementary particle physics and the space-time structure of the universe. These connections give new viewpoints to the old ideas about cosmology and atomic physics. The initial conditions resulting from the evolution and from the hot original state of the Universe are very important for the history of Earth, too. Secondly, geophysical researches about the history of the Earth are giving information about the "self-experienced" cosmology and about the proper history of the physical laws and constants. (auth)

46979 ULTIMATE TEMPERATURE AND THE EARLY UNIVERSE. Huang, Kerson; Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett.; 25: 895-7 (28 Sep 1970).

The early history of the universe is discussed in the context of an exponentially rising density of particle states. (auth)

46980 L_α LINE PROFILE AND THE SPIN TEMPERATURE OF HYDROGEN IN THE INTERGALACTIC MEDIUM. Varshalovich, D. A.; Syunyaev, R. A. (Ioffe Inst. of Physics and Tech., Leningrad. Inst. of Applied Mathematics, Moscow). Astrophysics (Engl. Transl.); 4: 140-4(Fall 1968).

Translated from Astrofizika; 4: 359-71(1968).

The spectral-line profile of the L_α emission of hydrogen in the case of a homogeneous and isotropic expanding intergalactic medium is calculated for different densities, degrees of ionization, and temperatures. As a result of the cosmologic redshift, the line profile has a steplike shape. Detailed experimental studies of the L_α profile of intergalactic hydrogen can, in principle, be used to determine the mean density of this gas, its temperature, the degree of ionization, the degree of homogeneity, the amount of dust, and the velocity of the Galaxy relative to the intergalactic gas. It is important to note that this can result in data on the evolution of the intergalactic medium. The effect of the L_α profile on the spin temperature of neutral intergalactic hydrogen is discussed. It is shown that when the slope of the L_α profile is taken into account, this is not sufficient to remove the discrepancy between measurements of the density of neutral intergalactic hydrogen based on absorption in the L_α and λ = 21 cm lines when the medium is homogeneous and ionization equilibrium prevails. (auth)

46981 BIG BANG COSMOLOGY AND HAGEDORN'S HADRONIC EQUATION OF STATE. Moellenhoff, C. (Univ. Goettingen, Ger.). Astron. Astrophys.; 7: 488-90(Sep 1970).

The first few minutes of a Friedmann universe are computed using Hagedorn's hadronic equation of state. The result is not in contradiction with the present state of observation in cosmology. The primordial He^4 abundance is not a decisive criterion for this equation of state. (auth)

46982 DENSITY OF THE UNIVERSE. Oort, J. H. (Leiden Observatory, Netherlands). Astron. Astrophys.; 7: 405-7(Sep 1970).

It is estimated that if the inception of spiral galaxies was due to large-scale currents, as indicated in the preceding article, at

most one sixteenth part of space will have condensed into spirals. The overall density in the Universe is probably at least fifteen times higher than that concentrated in the galaxies. For a Hubble constant of 75 km s^{-1} Mpc^{-1} the resulting minimum density is 0.5×10^{-29} g cm^{-3}, or half the critical density. The thermal radiation of this intergalactic gas, which must have a temperature between 10^8 and 10^9 °K, may be observable in the soft x-ray region. An excess radiation of the expected order of magnitude has in fact been observed around 0.25 keV, but the observations are still rather discordant, and their interpretation poses some unsolved problems. (auth)

46983 FORMATION OF GALAXIES AND THE ORIGIN OF THE HIGH-VELOCITY HYDROGEN. Oort, J. H. (Leiden Observatory, Netherlands). Astron. Astrophys.; 7: 381-404 (Sep 1970).

Observations of the high-velocity hydrogen at intermediate and high galactic latitudes are reviewed. The phenomena indicate that intergalactic gas is streaming into the Galaxy. No more than a rough estimate can be made of the total flow. The inflow provisionally adopted in the article is 2×10^{17} H atoms per cm^2 of the galactic plane per million years, corresponding with an increase of the Galaxy's mass of 0.9% per 10^9 years. The cloudy structure of the high-velocity gas is probably caused by the structure of the halo. An inflow of this order is plausible if one considers the probable origin of spiral galaxies. It is shown that these cannot generally have obtained their angular momentum by the action of external gravitational fields or by collisions in the course of their evolution. Therefore, they must have been endowed with their angular momentum from the beginning, and cannot have formed by gravitational instability from large-scale fluctuations directly after the fireball stage of the Universe, as commonly supposed. The Universe must thus have had a high degree of turbulence on a galactic scale, as was first proposed by von Weizsäcker. In order that enough momentum can be contained in a "proto-spiral," the scale of the Universe at the time of its inception should have been about 1/30 of the present scale. Initially the protogalaxies presumably expanded with the Universe, though at a much reduced rate. Their collapse into actual galaxies should have come much later (at $t \gtrsim 1 \times 10^9$ years). The age of most frequent galaxy collapses may well correspond with that of the birth of the majority of powerful radio sources, at $z \gtrsim 1$. Transition regions at the outer boundaries of the cells from which protogalaxies are formed, as well as natural irregularities in the rotation of these cells will make the infall of gas into the galaxies continue long after the principal collapse. The present-day inflow of intergalactic gas expected from this process of galaxy formation is of the order of that inferred from the observations. Compelling independent evidence for the existence of a great density of intergalactic matter is given by the relative motion of Andromeda and the Galaxy, as has previously been emphasized by Kahn and Woltjer. The intergalactic gas must have a high temperature. (auth)

46984 GALAXY FORMATION AND PRIMORDIAL TURBULENCE IN THE EXPANDING HOT UNIVERSE. Sato, Humitaka; Matsuda, Takuya; Takeda, Hidenori (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 1115-17(Apr 1970).

Gamow (1952) and Weizsäcker (1951) emphasized the importance of cosmic turbulence in the formation of astronomical objects. Recently, Chernin and Ozernoi (1968 and 1969) revitalized this idea in connection with galaxy formation following the hot Universe model based on the discovery of the cosmic black-body radiation. Here, their idea is expanded to explain the observed mass of a galaxy (or a cluster of galaxies) from a consideration of the scale of the turbulent eddies. (W.D.M.)

46985 POST-NEWTONIAN METRIC FOR A GENERAL CLASS OF SCALAR-TENSOR GRAVITATIONAL THEORIES AND OBSERVATIONAL CONSEQUENCES. Nordtvedt, Kenneth Jr. (Montana State Univ., Bozeman). Astrophys. J.; 161: 1059-67(Sep 1970).

A general class of scalar-tensor gravitational theories is considered in which the ω parameter of the Brans-Dicke theory is allowed to be an arbitrary (positive definite) function of the scalar field ($\omega \to \omega(\phi)$). The weak-field metric for slowly moving mass sources is obtained to order $1/c^4$ for g_{00}, allowing one to examine phenomenologically the question of whether experiments within the solar system can detect a possible $\omega' \equiv d\omega/d\phi \neq 0$. The post-Newtonian ($1/c^4$) metric is dependent only on the two parameters $\omega(\phi_0)$ and $\omega'(\phi_0)$, where ϕ_0 is the scalar-field value at this time in the Universe. A variety of experimental consequences of $\omega' \neq 0$ is found, including a contribution to the rate of precession of Mercury's perihelion. (auth)

46986 DIRECT DETERMINATION OF THE METRIC FROM OBSERVED REDSHIFTS AND DISTANCES. Weinberg, Steven (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Astrophys. J.; 161: L233-4(Sep 1970).

The measurement of redshifts and luminosity (or angular-diameter) distances cannot in principle be used to determine the sign or magnitude of the spatial curvature unless supplemented with a dynamical model. This ambiguity could be resolved by parallax measurements at cosmological distances. (auth)

46987 DISSIPATION OF PRIMORDIIL TURBULENCE IN THE EXPANDING UNIVERSE. Tomita, Kenji (Hiroshima Univ.); Nariai, Hidekazu; Sato, Humitaka; Matsuda, Takuya; Takeda, Hindenori. Progr. Theor. Phys. (Kyoto); 43: 1511-25(Jun 1970).

The decay laws of primordial turbulence and the heating rates by its dissipation are derived in the expanding medium, and it is shown that the matter in the expanding Universe cannot be heated and kept at temperatures higher than 10^5 °K, which are necessary for galaxy formation by thermal instability. The effects of its dissipation on hydrodynamic instability are discussed. (auth)

46988 STEADY-STATE COSMOLOGY AND QUANTUM ELECTRODYNAMICS. Boerner, Gerhard (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 1622-3(Jun 1970).

A possible relation between local phenomena of quantum electrodynamics and the large-scale structure of the Universe has been recently discussed by Hoyle and Narlikar (1968) (1969). They developed the Wheeler-Feynman electrodynamics. The attempt to formulate the usual quantum electrodynamics in the space-time frame of the theory of steady-state cosmology is discussed. (W.D.M.)

Planetary Phenomena

46989 SOLAR ACTIVITY AND THE GREAT RED SPOT OF JUPITER. Balasubrahmanyan, V. K. (Goddard Space Flight Center, Greenbelt, Md.); Venkatesan, D. Astrophys. Lett.; 6: 123-6(Aug 1970).

The darkness parameter of the Jovian red spot for the period 1891-1947 (Peek 1958) has been used in a quest for a possible Solar-Jovian relationship. An average behavior of this parameter is obtained by the Chree superposed epoch method of analysis, the years of solar maximum being used as the zero epochs. The result exhibits characteristic double maxima in the changes of the red spot over the average solar cycle. Since this feature is common to other observations of solar events in the photosphere, chromosphere, and corona, radio and corpuscular emissions from the Sun, cosmic-ray intensity, and geomagnetic activity, the study suggests a positive Solar-Jovian relationship. (auth)

Atomic and Molecular Physics

Refer also to abstract 46763.

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstracts 46716, 46717, 47256, 47292, and 47343.

46990 (CONF-690557-(Vol.1), pp 230-43) SOME COMMENTS ABOUT QUANTUM MECHANICAL COLLISION SPECTRA. Bichsel, Hans (California Univ., Berkeley. Lawrence Radiation Lab.).

Atomic collision cross sections used in calculation of energy losses of heavy charged particles in matter are discussed. The modifications brought about by use of quantum mechanical cross sections for bound electrons rather than cross sections for free electrons are described. Sources of inaccuracy in the calculations and further studies needed to obtain better accuracy are pointed out. (A.G.W.)

46991 X-RAY ABSORPTION OF POLYPROPYLENE, MELINEX, AND CARBON BETWEEN 44 AND 85 A. Denne, D. R. (Univ. of Stirling, Scotland). J. Phys., D (London); 3: 1405-6(Sep 1970).

New measurements of the x-ray absorption behaviour of polypropylene and Melinex in the wavelength interval 44 Å to 85 Å are presented. Mass absorption coefficients for carbon are also given. (auth) (UK)

46992 MEASUREMENTS OF THE ULTRASOFT X-RAY ABSORPTION OF Ar, Ne, N_2, O_2, CH_4, He, AND H_2. Denne, D. R. (Univ. of Leicester, Eng.). J. Phys., D (London); 3: 1392-8 (Sep 1970).

New measurements are presented of the x-ray absorption cross sections of argon, neon, oxygen, nitrogen, methane, carbon, helium, and hydrogen in the wave-length interval 23.7 to 82.1 Å. The values obtained are compared with the theories of Hall (1936) and Bearden (1966) and in the case of helium those of Huang (1968) and Stewart and Webb (1963). Further support is provided for Bearden's K-shell theory, but the agreement for the L-shell absorption region is shown to be poor. The empirical predictions of Henke et al. (1957) are also not supported. At shorter wavelengths the helium results lie closer to the theory of Stewart and Webb, based on calculation of the acceleration matrix element, than to Huang's predictions based on the momentum matrix element. An empirical absorption formula relating cross section, wavelength and atomic number is given capable of predicting the experimental results satisfactorily. (auth) (UK)

46993 SECONDARY ELECTRON EMISSION OF MOLYBDENUM CRYSTALS. Shul'man, A. R.; Korablev, V. V.; Morozov, Yu. A. (Kalinin Leningrad Polytechnic Inst., USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 586-9(Sep 1970).

Translated from Fiz. Tverd. Tela; 12: 758-62(Mar 1970).

In a study of secondary electron emission at (111) and (102) faces of molybdenum single crystals, the primary-energy dependences of the total secondary yield and the inelastic-reflection yield, as well as the maximum values of these yields, were found to differ for samples having different crystallographic faces at the surface. The angular dependences of the secondary-emission yields were studied for primary energies in the range 100 to 2000 eV. The results are explained on the basis of channeling theory. (auth)

46994 SECONDARY ELECTRON EMISSION AND SOME FEATURES OF ELECTRON MOTION IN MOLECULAR CRYSTALS. Martsinovskaya, E. G. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.); 12: 716-17(Sep 1970).

Translated from Fiz. Tverd. Tela; 12: 922-4(Mar 1970).

The features of secondary electron emission from molecular crystals, such as organic semiconductors, may be explained on the basis of a "compressed gas" model. The energy loss of primary electrons without formation of secondary electrons and the potential barrier are two possible causes of the low values of δ in molecular crystals. The experimental values of λ (depth of output of slow secondary electrons) indicate the presence of elastic collisions. (D.L.C.)

46995 QUANTITATIVE COMPARISON OF CALCULATED AND MEASURED ELECTRON ENERGY LOSS SPECTRA OF SILVER. INFLUENCE OF RETARDATION AND FOIL STRUCTURE. Zacharias, P. (Univ., Hamburg). Z. Phys.; 238: 172-83(1970). (In German).

Energy loss measurements on the plasma loss of silver were carried out with monochromatic 51-keV electrons. The loss spectra were compared with calculated ones. If retardation is taken into account, the intensity formula describes the experimental results correctly. The experiments were extended to silver foils with extremely fine crystallites. These films have a dielectric constant with a higher imaginary part (ϵ_2) than the usual silver foils. The calculated spectra are again in good agreement with the observed ones, if retardation is taken into account. (auth)

46996 MOLECULAR BEAM STUDY OF THE SCATTERING OF RARE GASES FROM THE (110) FACE OF A TUNGSTEN CRYSTAL. Yamamoto, S.; Stickney, R. E. (Massachusetts Inst. of Tech., Cambridge). J. Chem. Phys.; 53: 1594-1604(15 Aug 1970).

The scattering of He, Ne, Ar, and Kr from a (110) tungsten surface was investigated for surface temperatures, T_s, in the range 300° to 2100°K and for angles of incidence, θ_i, of 40, 50, and 60 deg. The apparatus consists of a nozzle-type molecular beam modulated at 2650 Hz so that lock-in detection may be used to determine both the mean speed and density patterns of the scattered gas. The majority of the data are for $T_s = 2100$°K since thermal desorption of contaminants should be sufficiently rapid at this temperature to insure that the surface is essentially clean. (For $T_s < 1000$°K, the surface became contaminated by residual gases (primarily CO) before measurements could be obtained.) At $T_s = 2100$°K, the maxima of the density patterns for $\theta_i = 40$, 50, and 60 deg are at the specular angles for He, whereas they are increasingly subspecular for Ne, Ar, and Kr. Both the mean speed and density patterns are compared with the theoretical predictions of the hard-cube and soft-cube models. (auth)

46997 EVIDENCE OF PLASMONS IN SECONDARY ELECTRON EMISSION SPECTRA. von Koch, Claus V. (Goettingen Univ., Hanover). Phys. Rev. Lett.; 25: 792-4(21 Sep 1970).

New secondary electron emission spectra were obtained by a rapid analyzer, which presents the full spectra in the range from 0 to 100 eV in 1 msec on an oscilloscope. The spectra show distinct peaks corresponding in energy to the volume and surface plasmons: for Al at 15.2 eV; Al_2O_3 at 31, 22.5, and 17.5 eV; and KCl at 13.6, 9, and 7 eV. It is suggested that these groups of secondary electrons originate from plasmon decay. (auth)

Atomic and Molecular Properties

Refer also to abstract 47330.

46998 (NP-18278) METHOD FOR DETERMINING PARAMETERS OF ATOMIC STRUCTURE IN PLASMA RADIATION THEORY. Lucian, Brindus (Academia R. S. R., Bucharest, Institutul de Fizica Atomica). 1970. 20p. (In Rumanian). Dep. CFSTI (U. S. Sales Only).

Thesis (summary). Submitted to Univ., Bucharest, Romania.

The wave functions needed to calculate the matrix elements are obtained by the numerical solution of a system of coupled integral-differential equations on the basis of the Hartree-Fock method; however, this method is not suited for application in the quantum theory of radiations. Layzer's method, which involves the solution of a system of nonlinear algebraic equations, yields atomic screening parameters for the states defined by the LS coupling. A new method was developed for obtaining the atomic screening parameters without requiring computers for carrying out the calculations. The method may be used to determine these parameters for the excited states of inert gases, described by the jl coupling. It may be also used to calculate excitation cross sections, transition probabilities and photoionization cross sections for an atom with N electrons. The calculation was based on electron collision data and on analytical expressions. In plasma physics studies, the thermionic method was correlated with that based on the screening parameters in order to estimate the photoionization cross sections. (tr-auth) (TTT)

46999 PROTON EXCITATION OF CONTINUOUS EMISSION IN THE NOBLE GASES. Stewart, T. E.; Hurst, G. S.; Bortner, T. E.; Parks, J. E.; Martin, F. W.; Weidner, H. L. (Univ. of Kentucky, Lexington). J. Opt. Soc. Amer.; 60: 1290-7(Oct 1970).

Protons were used to excite the noble gases, He, Ne, Ar, Kr, and Xe, and the spectra of light emitted in the vacuum-ultraviolet (vuv) region were measured. The same gases were excited with a gas-discharge source operating in the spark mode. While it is well known that the spectral shape depends on the discharge conditions, the spectra of purified noble gas were found to be quite stable and reproducible when excited with protons. In most instances, the continuous spectra excited by the charged particles differ greatly from the discharge spectra at the same pressure. In both cases the spectra depend on the pressure, but in a much less complicated way in the case of proton excitation. With fast protons, the total number of photons emitted per second per centimeter of proton track and per microampere of proton beam current was also determined. The energy radiated in the vuv region per centimeter of proton track length is an appreciable fraction of the proton stopping power for all the stable noble gases. (auth)

47000 ZEEMAN RESULTS IN Dy II. Vander Sluis, K. L.; McNally, J. R. Jr. (Oak Ridge National Lab., Tenn.). J. Opt. Soc. Amer.; 60: 1209-12(Sep 1970).

The Zeeman structures at 49 430 Oe of 129 transitions terminating on the 10 lowest levels of the $4f^{10}6s$ configuration of ^{163}Dy II were measured and analyzed. The values of the g factors derived from these data agree well with preliminary theoretical values. (auth)

47001 HYPERFINE STRUCTURE IN THE ^{253}Es EMISSION SPECTRUM. II. NUCLEAR SPIN, NUCLEAR MAGNETIC DIPOLE MOMENT, AND ENERGY LEVELS OF Es II. Worden, Earl F. (Univ. of California, Livermore); Gutmacher, Ralph G.; Lougheed, Ronald W.; Conway, John G.; Mehlhorn, Rolf J. J. Opt. Soc. Amer.; 60: 1297-1302(Oct 1970).

Fifty-three emission-spectrum lines of einsteinium have been observed. The interval between the ground level $^5I_8$ and the first excited level $^5I_7$ of Es II has been found to be 938.66 cm^{-1}. The hyperfine structure confirms that the nuclear spin of ^{253}Es is $7/2$. A value of $\mu_I = (+5.1 \pm 1.3)\mu_N$ was obtained for the nuclear magnetic dipole moment. (auth)

47002 AN APPROXIMATE TREATMENT OF THE SHORT-RANGE COLLISION PROBLEM INVOLVED IN THE STARK BROADENING OF HYDROGEN LINES. Nguyen-Hoe; Caby, Monique (Paris Univ.). Compt. Rend., Ser. B; 270: 1657-60(29 Jun 1970). (In French).

Several approximations were made in the solution of the Stark broadening equation of hydrogen lines. These approximations were then used in solving the problem of the broadening by electron impact of the Ly-α hydrogen line. The value obtained for the short-range impact parameter ($c_p = 1.70$) was compared with other available results. (tr-auth) (France)

47003 IONIZATION ENERGIES OF Ce I AND Gd I. Reader, Joseph; Sugar, Jack (National Bureau of Standards, Washington, D. C.). J. Opt. Soc. Amer.; 60: 1421-2(Oct 1970).

The ionization energies of cerium and gadolinium were derived from experimental observations of the properties of the $4f^N6sns$ series. Values of 5.47 ± 0.02 eV for cerium and 6.13 ± 0.02 eV for gadolinium were obtained. (A.G.W.)

47004 INTRODUCTION TO ATOMIC AND MOLECULAR STRUCTURE. Barrett, J. London; John Wiley and Sons Ltd. (1970). 327p. 50s.

The purpose of the book is to give a basis for a general understanding of the aims, techniques, and successes of chemical theory under the following headings: the quantization of electromagnetic radiation; the quantization of electron energies in atoms and molecules; the diffraction of electrons and the uncertainty principle; quantum mechanics; the application of quantum mechanics to atomic problems; the periodic classification of the elements; combination of atoms; the formation of diatomic molecules, triatomic molecules, other polyatomic molecular systems; the solid state and the bonding in ionic compounds and metals, molecules, and ions containing transition elements. (UK)

47005 SHAPE-RESTRICTED WAVE FUNCTIONS: TWO-CENTER SPHERICAL LIMITS FOR H_2^+. Katriel, J.; Adam, G. (Nuclear Research Centre, Negev, Israel). Chem. Phys. Lett.; 6: 431-4(1 Sep 1970).

The two-center spherical limits for the energies, $\langle x^2 \rangle$, $\langle z^2 \rangle$, equilibrium distances, and vibration frequencies are obtained for the ground state of H_2^+. It is found, inter alia, that linear combination of two floating spherical functions approximates the exact ground-state energy to within 0.7%. (auth)

47006 POLYNOMIAL APPROXIMATION OF PARTITION FUNCTIONS. Bolton, C. T. (Univ. of Michigan, Ann Arbor). Astrophys. J.; 161: 1187-8(Sep 1970).

Algorithms are given that will allow the rapid computation of the temperature-dependent portion of partition functions for the neutral and singly ionized states of ten common elements. The algorithms are accurate to better than 4% for a temperature range from 3537° to 20160°K. (auth)

47007 AB INITIO CALCULATIONS OF HARMONIC FORCE CONSTANTS. III. AN EXACT CALCULATION OF THE H_3^+ FORCE CONSTANT. Bishop, David M. (Univ. of Ottawa). J. Chem. Phys.; 53: 1541-2(15 Aug 1970).

The energy, within the Born-Oppenheimer approximation, of the $1s\sigma_g$ state of H_2^+ is evaluated for internuclear separations of 1.90 to 2.10 a.u. in steps of 0.01. These energies are used to determine the force constant of H_2^+ in the $1s\sigma_g$ state; it is found to be 0.102970438 a.u. (auth)

47008 MULTIPOLE POLARIZABILITIES AND LONDON DISPERSION FORCES OF He AND Li^+ USING DOUBLE PERTURBATION THEORY. Broussard, J. T.; Kestner, Neil R. (Louisiana Univ., Baton Rouge). J. Chem. Phys.; 53: 1507-10(15 Aug 1970).

Following the double perturbation-theory method used by Deal, Kestner, and Young, dipole, quadrupole, and octupole polarizabilities with and without correlation have been calculated for He and Li^+ at imaginary frequencies. Also calculated are the C_6, C_8, and C_{10} coefficients for He-He and Li^+-Li^+ interactions with and without correlation for several Hartree-Fock-type wave functions. (auth)

47009 SURFACE AND VACUUM PHYSICS INDEX. VOLUME 5, NO. 7, 1970. Bibliography, Author Index, Subject Index in Alphabetical Order, Cumulative Subject Index in Logical Order. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 84p.

This listing includes 353 articles on various aspects of the above subject. (M.O.W.)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstract 47383.

47010 (CONF-690557-(Vol.2), pp 639-68) K-MESONIC X RAYS FROM LOW-Z NUCLEI. Burleson, G. R. (Northwestern Univ. [Evanston, Ill.]).

The present status of experimental measurements of K-mesonic x rays from nuclei having $Z \leq 6$ is summarized. The principal results to date are as follows: (1) A model of mesonic cascades in He atoms has been produced that is consistent with muon and pion x-ray results, null kaon x-ray results, experimental K-He scattering lengths, bubble chamber measurements of cascade times, and various nuclear models involving $\bar{K}$-N scattering lengths. This model implies predominantly p-state capture of kaons, but it also allows some s-state and d-state capture. (2) The absorption rates of kaons in nuclei with Z between 2 and 6, as determined by cascade calculations, are consistent within experimental error with a simple model involving only kaon-nucleon s-state interactions. (3) No x-ray line corresponding to transitions to a level that overlaps the nucleus sufficiently to show a measurable energy shift has been observed. A brief review of the present situation with π and μ x rays is included as an indication of the direction that studies of K x rays might take. (A.G.W.)

47011 (CONF-690557-(Vol.2), pp 669-93) MEASUREMENTS OF KAONIC X RAYS OF MEDIUM AND HEAVY ELEMENTS. Wiegand, Clyde E.; Kunselman, Raymond (California Univ., Berkeley. Lawrence Radiation Lab.).

Some results of measurements of kaonic x rays from medium and heavy elements are presented. Interpretation of the results in relation to capture processes and properties of the nuclear surface is discussed. It is suggested that the kaons are absorbed by nucleons above the conventional nuclear surface. (A.G.W.)

47012 (CONF-690557-(Vol.2), pp 694-707) K^- MESIC ATOMS. Rook, J. R. (Oxford Univ. (England). Nuclear Physics Lab.).

Measurements of x-ray yields from K^- mesic atoms of nuclei between ^{7}Li and ^{12}C are analyzed. Three processes involved in kaon capture by atoms are considered: x-ray emission, the Auger effect in which the meson interacts with the atomic electrons, and nuclear capture. Rates for these processes are calculated and their relative importance is considered. (A.G.W.)

47013 POSITRONIUM DECAY IN CONDENSED MATTER. Brandt, Werner; Fahs, James H. (New York Univ., N. Y.). Phys. Rev., B; 2: 1425-7(1 Sep 1970).

In earlier papers [Phys. Rev., 120: 1289(1960); 142: 231(1966)], the pickoff annihilation rate of positronium was calculated in a cell approximation for various cell geometries. The rate can be expressed in terms of two functions $F(S,v^*)$ and $\xi(S,v^*)$ that depend on a cell potential parameter S and the reduced cell volume v^*. These functions are rederived and previous errors corrected. Extensive numerical tabulations are made available and analytical approximations presented. (auth)

Collision Phenomena

Refer also to abstracts 46545, 46935, and 47556.

47014 (ORO-3027-17) ABSOLUTE EXPERIMENTAL CROSS SECTIONS FOR THE EXCITATION OF Ba^+ IONS BY ELECTRON IMPACT. Pace, M. O.; Hooper, J. W. (Georgia Inst. of Tech., Atlanta. School of Electrical Engineering). 1 Sep 1970. Contract AT(40-1)-3027. 114p. Dep. CFSTI.

The crossed-beam technique was used to measure absolute emission cross sections for the excitation of electric dipole transitions in the Ba^+ ion by electron impact at energies near and below threshold. The basic experimental method involves intersecting modulated ion and electron beams at right angles in a well-defined collision volume. A portion of the photon flux radiated from the collision volume by excited ions is detected by an optical system viewing the collision volume along the axis perpendicular to both beams. The total emission is calculated from the portion detected using the experimentally determined response of the detection system to isotropic radiation and a correction for anisotropy, obtained from the polarization of detected emission. The emission cross section is then calculated from the total emission, the two beam currents and their spatial distributions, and the energies. The cross sections measured are absolute in the strict sense that the optical detection system was calibrated with a light standard by a technique that takes into account all spatial and spectral variations. The only other experimental result available for comparison is in agreement well within the combined experimental uncertainty. Available theoretical calculations compare poorly with the present results, as well as with each other. This is attributed to the rather drastic approxi-

mations used in the theoretical calculations. The results obtained from the Born approximation apparently overestimate the cross section, which is typical for that type of calculation at low energies. (auth)

47015 (RPI-4144-1) RESEARCH ON SLOW ELECTRON COLLISION PROCESSES IN GASES. Technical Progress Report, September 15, 1969–May 31, 1970. Baldwin, George C. (Rensselaer Polytechnic Inst., Troy, N. Y. Dept. of Nuclear Science). Jul 1970. Contract AT(30-1)-4144. 21p. Dep. CFSTI.

Progress made during the period on an investigation of collisions of very slow electrons (below 2 eV) in gases with the aid of time-of-flight velocity selection is reported. Emphasis is on the apparatus and procedures; a diagram is shown and development of techniques is discussed. Some preliminary total-cross-section measurements on H_2, O_2, and N_2 taken in the course of testing equipment and procedures are included. (A.G.W.)

47016 ANGULAR DISTRIBUTION OF ELECTRONS EJECTED BY CHARGED PARTICLES. I. IONIZATION OF He AND H_2 BY PROTONS. Bonsen, T. F. M. (Rijksuniversiteit, Utrecht); Vriens, L. Physica; 47: 307-19(29 May 1970).

Cross sections for ejection of electrons from He and H_2 by 100- to 2000-keV protons were calculated with the binary-encounter theory. Comparisons are made with experimental and with Born cross sections. The binary-encounter cross sections agree very well with the experimental ones for intermediate ejection angles and not too small ejection energies. The discrepancies found at small and at large angles are discussed in some detail. (auth)

47017 ANGULAR CORRELATION OF SCATTERED AND EJECTED ELECTRONS IN IONIZING COLLISIONS. II. Vriens, L. (FOM Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica; 47: 267-76(29 May 1970).

The differential cross section $\sigma(\epsilon, \hat{k}_s, \hat{k}_e)$ for scattering of a fast electron with an energy loss ϵ in a direction $\hat{k}_s$, and a simultaneous ejection of an atomic electron in a direction $\hat{k}_e$, is derived with the binary-encounter theory and compared with the corresponding Born and plane-wave Born cross sections. In all cases the formulas are properly symmetrized so as to account for interference between direct and exchange scattering amplitudes. The binary-encounter and classical (Gryzinski, Stabler, Gerjuoy, etc.) collision theories are shown to be special approximations of the plane-wave Born approximation, in that all differential and total binary-encounter and classical cross-section formulas can be derived from it. It is discussed how the resulting formulas can be used in the analysis of experimental data, for example such as reported by Amaldi et al. (auth)

47018 GENERALIZED OSCILLATOR STRENGTH INVOLVED IN THE ELECTRON-IMPACT EXCITATION OF THE 3^1P, 4^1P, AND 5^1P STATES OF HELIUM. Peresse, Joseph; Le Nadan, Andre; Gelebart, Francois (Brest Univ., France). Compt. Rend., Ser. B; 271: 100-2(15 Jul 1970). (In French).

The validity of the Born approximation for the $1^1S \rightarrow n^1P$ transitions of helium occurring between 35 and 150 eV is demonstrated for an angular range between 0 and 20°; the generalized oscillator strengths for the transitions are determined. (tr-auth) (France)

47019 MODELS, INTERPRETATIONS, AND CALCULATIONS CONCERNING RESONANT ELECTRON SCATTERING PROCESSES IN ATOMS AND MOLECULES. Taylor, H. S. (Univ. of Southern California, Los Angeles). Advan. Chem. Phys.; 18: 91-147(1970).

A review is given of the understanding of physical models of resonance that appear useful in predicting and interpreting experimental results concerning such processes as resonant electron scattering, autoionisation, associative detachment, dissociative attachment, and similar molecular resonant reactions in small molecules such as H_2, N_2, and CO, as well as electron scattering in atomic systems, on a qualitative basis. The models considered will also prove useful in suggesting first approximations for state functions in iterative processes for calculating the energy and widths of resonant states. The stabilisation method of calculating resonant energies and widths is also discussed. Headings are as follows: mechanistic model for resonance; the stabilisation method (introduction, heuristic approaches, suggestive and related problems, the mathematical description of resonance); angular dependence in the vibrational excitation process in N_2, CO_2, and H_2; resonant phenomena in H_2; use of the one-electron model in the qualitative understanding and choices of significant experiments; and resonant scattering for He. (72 references) (UK)

47020 IMPROVED TOTAL INELASTIC SCATTERING CROSS SECTION FOR THE RARE GASES. Bonham, R. A. (Tokyo Univ. Indiana Univ., Bloomington); Ng, E. W. Chem. Phys. Lett.; 6: 403-6(1 Sep 1970).

New calculations for the total inelastic electron scattering cross sections for the elements H, He, Ne, Ar, and Kr at incident electron energies of 500 eV and 40 keV are presented. The calculations are given for both an old and a new formula for the total inelastic scattering cross section and are compared where possible with the results of more rigorous calculations. The new results predict that the total inelastic scattering cross sections will be lower for the heavier elements by a factor of 2 to 4 than previously reported. In addition the value of the cross section for Ne in the low-energy region is found to be surprisingly small. (auth)

47021 ROTATIONAL EXCITATION IN MOLECULAR COLLISIONS: CORRECTIONS TO A STRONG-COUPLING APPROXIMATION. Tsien, Thomas P.; Pack, Russell T. (Brigham Young Univ., Provo, Utah). Chem. Phys. Lett.; 6: 400-2(1 Sep 1970).

A first-order iteration (analogous to that used in the distorted wave approximation) of Takayanagi's quantum-mechanical strong-coupling approximation for rotationally inelastic collisions is discussed and applied to a model problem. (auth)

47022 CROSSED-MOLECULAR-BEAM MEASUREMENT OF THE N_2 + Ar DIFFERENTIAL ELASTIC CROSS SECTION: ENERGY DEPENDENCE OF THE RAINBOW SCATTERING. Kalos, Ferenc; Grosser, Arthur E. (McGill Univ., Montreal). Chem. Phys. Lett.; 6: 537-40(1 Sep 1970)

Differential cross sections for the scattering of N_2 (velocity-selected beam) by Ar (nozzle beam) were measured at different kinetic energies in the range $E = 7.73$ to 15.6×10^{-14} erg. From the rainbow scattering the well depth $\epsilon = 1.63 \pm 0.15 \times 10^{-14}$ erg was deduced for an assumed Lennard–Jones (12,6) potential. The scattering at low angles exhibited classical behavior corresponding to a $V \propto \gamma^{-4}$ long-range potential. (auth)

47023 EXACT QUANTUM-MECHANICAL CALCULATION OF INELASTIC TRANSITION PROBABILITIES OF A COLLINEAR COLLISION OF A PARTICLE WITH A MORSE OSCILLATOR. Hunding, Axel (Univ. of Copenhagen). Chem. Phys. Lett.; 6: 444-6(1 Sep 1970).

The exact transition probabilities for the Morse oscillator are found to be smaller than those of the harmonic oscillator by a factor varying from 5 to 10. The proper first-order distorted-wave treatment predicts the effect qualitatively, but not quantitatively. (auth)

47024 PHOTOIONIZATION CROSS-SECTIONS FOR ATOMS AND IONS OF CARBON, NITROGEN, OXYGEN, AND NEON. Henry, Ronald J. W. (Louisiana State Univ., Baton Rouge). Astrophys. J.; 161: 1153-5(Sep 1970).

Photoionization cross sections for all levels belonging to the ground-state configuration of atoms and ions of C, N, O, and Ne are fitted to an interpolation formula which gives the cross sections as a function of wavelength. The close-coupling approximation is used to obtain photoionization cross sections for C, C^+, N^{2+}, O^{3+}, and Ne^{4+} and for excited levels of all atoms and ions. The remaining data are quoted from previous calculations in which the same method of computation was used. (auth)

47025 DIFFERENTIAL SCATTERING RATES IN THE FORMATION OF METASTABLE HELIUM ATOMS BY ELECTRON COLLISIONS. Willems, G.; Taubert, R. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Naturforsch.; 25a: 449-51(Mar 1970). (In German).

The scattering rates of metastable helium atoms were studied through the crossing of an electron beam with a well-collimated helium atom beam at an angle of 90°. The metastable atoms produced by collision with electrons of various energies were measured with a movable detector. Results are presented in four diagrams. (H.B.G.)

47026 APPLICATION OF FADDEEV EQUATIONS AND THE COULOMB T-MATRIX TO ELECTRON CAPTURE IN HYDROGEN. Carpenter, Chester P. Cincinnati; Univ. of Cincinnati (1969). 125p. University Microfilms Order No. 70-9001.

Thesis.

The application of Faddeev's equations together with the Coulomb two-body T-matrix to a three-body rearrangement collision problem in which electrons are captured by fast protons in passing through atomic hydrogen is treated. The closed form for the T-matrix is taken from the work of Hostler. The integrals are reduced by using the strong peaking technique of Drisko and by using the properties of the bound-state poles. Contributions to the scattering amplitude arising from both the continuum and bound states are calculated. In the high-energy limit the contribution from the bound states is summed. The dependence of the contribution to the matrix element arising from the bound states

on the velocity of the incoming protons decreases much faster than does the contribution arising from the continuum states. The contribution to the matrix element arising from the continuum states differs from Drisko's result by a phase factor. (Diss. Abstr. Int., B)

47027 CROSS SECTION FOR EXCITATION OF ATOMIC HYDROGEN TO THE METASTABLE $2^2S_{\frac{1}{2}}$ STATE BY ELECTRON IMPACT: POLARIZATION OF LYMAN ALPHA RADIATION PRODUCED IN PROTON–ATOM COLLISIONS. Kauppila, Walter Eric. Pittsburgh; Univ. of Pittsburgh (1969). 189p. University Microfilms Order No. 70-8626.

Thesis.

The cross section for excitation of atomic hydrogen to the $2^2S_{\frac{1}{2}}$ state by electron impact was measured in a modulated crossed-beam experiment in the energy range extending from threshold to 1000 eV. Absolute values for the 2S cross section were obtained by measuring the ratio of the 2S to 2P cross sections and using previous measurements of the 2P cross section, which were normalized to the Born approximation at high energies. The atoms excited to the 2P and 2S states were detected by observing the Lyman-alpha photons produced by radiative decay and by quenching in an electrostatic field, respectively. The measured cross section is found to be in agreement with the Born approximation above 200 eV. The measured cross section ratios are in reasonable agreement with the ratios that would be predicted by the close-coupling theory of Burke et al. The peak value of the cross-section curve is (0.168 ± 0.020) πa_0^2 and occurs at (11.6 ± 0.2) eV. In another experiment, the polarization of Lyman-alpha radiation produced in charge-transfer collisions between protons and the inert gas atoms Ar, Ne, and He was measured for proton energies extending up to 24 keV. The measured polarizations were found to exhibit some structure as a function of energy and a correspondence was found between features of the measured polarization curves and previous measurements of the cross sections by Pretzer, Van Zyl, and Geballe. A theoretical description by Poluektov and Presnyakov of the underlying processes contributing to the structure found in the measured cross section curves is consistent with the present polarization measurements. In general, the measured polarizations were near zero. The polarization of Lyman-alpha radiation produced by direct excitation of hydrogen atoms by proton impact was also measured for proton energies extending from 2 to 21 keV. The measured polarization fractions as a function of energy were found to be in partial agreement with the calculations of Gallaher and Wilets who used an impact-parameter approach with 4 coupled states in the Sturmian representation. The measured polarizations are near zero for proton energies below 10 keV and are positive for energies between 10 and 21 keV. The polarization of the countable ultraviolet radiation produced by direct excitation of hydrogen molecules by proton impact was measured and found to be positive and slowly decreasing as a function of energy. (TSS) (Diss. Abstr. Int., B)

47028 MOLECULAR BEAMS AND REACTION KINETICS. Course XLIV of Proceedings of the International School of Physics Enrico Fermi, Varenna, Italy, July 29th–August 10th, 1968. Schlier, Ch. (ed.). New York; Academic Press Inc. (1970). 455p. $20.00.

Twenty-six lectures related to the application of molecular-beam techniques to problems of reaction kinetics are included. The course starts with lectures on elastic and inelastic scattering. The subject of reactions is extended to include ionic reactions and reactions of the electron (excitation transfer). Nonbeam methods and the relation between beam and nonbeam results are then treated. Case studies of H^+ and H transfer are included. A final group of lectures discusses the present state of theory in the field. (A.G.W.)

47029 IONIZATION COLLISIONS AND Li^+, Li^{2+}, AND Li^{3+} ION CHARGE EXCHANGE IN GASES (0.2 TO 2 MeV). Pivovar, L. I.; Levchenko, Yu. Z.; Krivonosov, G. A. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz.; 59: 19-28(Jul 1970). (In Russian).

The effective cross sections for formation of slow positive ions and free electrons during the ionization of H_2, N_2, He, Ar, and Kr gases by 0.2- to 2.0-MeV Li^+, 0.6- to 0.2-MeV Li^{2+}, and 1.2- to 2.0-MeV Li^{3+} ions are measured. The cross sections for electron loss and electron capture by Li^+, Li^{2+}, and Li^{3+} ions are also measured. The cross sections for net ionization are estimated on the basis of the data obtained. Where possible the Bethe formula is employed for determining the effective charge of the lithium ions. (auth)

47030 GLORY SCATTERING OF LITHIUM BY A SERIES OF MOLECULES. III. SPHERICAL-TOP MOLECULES. Rothe, Erhard W. (General Dynamics/Convair, San Diego, Calif. Wayne State Univ., Detroit); Helbing, Reinhard K. B. J. Chem. Phys.; 53: 1555-9(15 Aug 1970).

The velocity dependence of the total cross section was measured for the scattering of lithium-7 by 10 spherical-top molecules. The experiments were similar to those described in two previous papers in which the scattering was from 13 diatomics and from 29 polyatomics containing carbon, hydrogen, and fluorine. Potential parameters are derived. The quenching of the normal glory patterns is measured. Anisotropy parameters are obtained, using a "clover-leaf" potential. (auth)

47031 QUENCHING OF GLORY UNDULATIONS FOR SCATTERING FROM POLYATOMIC MOLECULES: CLOVER-LEAF MODEL FOR SPHERICAL-TOP MOLECULES. Helbing, Reinhard K. B. (Univ. of California, Los Angeles. General Dynamics/Convair, San Diego, Calif.). J. Chem. Phys.; 53: 1547-54 (15 Aug 1970).

A formula is derived, which describes the quantum-mechanical analog to Huygens' principle in optics. From this the quantum-mechanical analog to Kirchhoff–Fraunhofer diffraction is formulated and is used to calculate small-angle differential cross sections and total cross sections. Complex scattering phase shifts (optical potentials) are easily accommodated. The method is applied to the case of glory quenching, employing potential models ("breathing sphere," "clover leaf," and certain combinations) that can be carried through analytically. As an example, the clover-leaf model was chosen for comparison with experimental data. By applying some suitable approximations the quenching effect can be expressed in simple known terms, both as far as quenched glory amplitudes as well as "misplaced" and "distorted" glory extrema are concerned. For glory scattering from spherical-top molecules (tetrahedral molecules) the clover-leaf model seems to offer a reasonable approximation. It can be used to derive potential parameters and anisotropy parameters. (auth)

47032 NEGATIVE ION FORMATION IN SELECTED HEXAFLUORIDE MOLECULES. Stockdale, J. A. D.; Compton, R. N.; Schweinler, H. C. (Oak Ridge National Lab., Tenn.). J. Chem. Phys.; 53: 1502-7(15 Aug 1970).

Negative ion formation in gaseous SeF_6, TeF_6, MoF_6, ReF_6, and UF_6 has been studied as a function of incident electron energy in the region from 0 to ~10 eV. Negative hexafluoride ions formed by direct electron attachment were observed only in the cases of MoF_6 and ReF_6. SeF_6^-, TeF_6^-, and UF_6^- were produced by charge exchange with thermal SF_6^-* and rates for these reactions and for the reaction $UF_6^- + UF_6 \rightarrow UF_6^- + UF_5$ were measured and are reported here. Electrons having energies close to zero are known to attach to SF_6 with a cross section approaching the maximum for s-wave capture. The excited negative ion SF_6^-* formed in this way has a lifetime of 26 μsec against autodetachment of the electron. An argument based on molecular orbital theory is given for the existence of a Jahn–Teller effect in SF_6^-. This could provide a means for the coupling between electronic and nuclear motion needed to trap the low-energy electron. Selenium and tellurium lie directly under sulfur in the same column of the periodic table, but the large spin–orbit splittings expected in SeF_6 and TeF_6 should dominate any Jahn–Teller effect in these otherwise similar molecules. The suggestion that a Jahn–Teller effect provides the coupling mechanism between electronic and nuclear motion is partially supported by the observation that ReF_6 (large Jahn–Teller distortion) strongly captures slow electrons to form ReF_6^-*. (auth)

47033 THEORETICAL TREATMENT OF PENNING IONIZATION: He(1s2s ^1S, ^3S) + H(1s ^2S). Miller, William H.; Schaefer III, Henry F. (Univ. of California, Berkeley). J. Chem. Phys.; 53: 1421-7(15 Aug 1970).

The potential curves involved in the Penning ionization of the hydrogen atom by helium metastables were computed by a large-scale configuration interaction. These are the potentials of the He–H system that dissociates to a ground-state H atom and He atom in the four states 1s2s ^1S, ^3S, 1s2p ^1P, ^3P; the ground-state $He-H^+$ potential curve is also required. A simplified description of the ionizing collision is introduced, which permits the determination of approximate cross sections (total ionization cross sections, associative ionization cross sections, the energy distribution of the ionized electron, etc.) without knowledge of the autoionization rate; numerical applications to the He* + H system are presented. (auth)

47034 ANGULAR DEPENDENCE OF DIFFERENTIAL CROSS SECTIONS FOR ELECTRON EXCITATION OF SINGLET – TRIPLET TRANSACTIONS. Steelhammer, J. C.; Lipsky, Sanford (Univ. of Minnesota, Minneapolis). J. Chem. Phys.; 53: 1445-54 (15 Aug 1970).

The failure of previous calculations to predict the correct "forward-peaking" angular dependence of the electron-impact differential cross section for the helium $1^1S \rightarrow 2^1S$ transition is shown to be due to the neglect of the core contribution. Even a

simple approximation to the full Born–Oppenheimer transition amplitude based on an expansion in inverse powers of the incident electron momentum predicts the correct angular dependence of this transition for electron energies to within 40 eV of threshold. For electron-impact excitation of the lowest singlet → triplet transition in molecular hydrogen, the peaking of the differential cross section away from zero scattering angle is due mainly to a molecular diffraction effect, and the success of Ochkur's approximation in predicting this dependence is shown to be merely a consequence of the relatively small contribution made by the core terms for this particular transition and cannot be generalized. For higher singlet → triplet transitions in H_2, the angular dependence of the differential cross section and the magnitude of the core contribution are shown to depend importantly on the separated atom state with which the molecular wave function correlates at infinite separation. (auth)

47035 SCATTERING FACTORS FOR ATOMIC LITHIUM FROM CORRELATED AND INDEPENDENT PARTICLE MODEL WAVEFUNCTIONS. Benesch, Robert; Smith, Vedene H. Jr. (Queen's Univ., Kingston, Ont.). J. Chem. Phys.; 53: 1466-70 (15 Aug 1970).

The natural orbital (NO) expansion of a highly accurate Hylleraas-type wave function (99.90% of the correlation energy) is used for the determination of correlated x-ray scattering factors for the ^2S ground state of the lithium atom. Correlated electron scattering amplitudes are also obtained within the first Born approximation. For purposes of comparison, scattering factors for this system were computed from various independent-particle-model (IPM) wave functions. Calculations based on the best density and symmetry-adapted best density determinants for Li yielded better approximations to the correlated NO scattering factor values than did those based on conventional IPM's. The latter included restricted and spin-polarized Hartree–Fock functions. The accuracy of x-ray scattering factors and electron scatterimg amplitudes is seen to depend on the value of the scattering variable μ. Although relative differences between the correlated and various HF values never exceed 1% for any given value of μ, these differences can be attributed almost entirely to "one-electron" rather than to "pure correlation" effects. (auth)

47036 RELATION BETWEEN SYMMETRIC AND ASYMMETRIC CHARGE EXCHANGE. Storm, David (Polytechnic Inst., Brooklyn); Rapp, Donald. J. Chem. Phys.; 53: 1333-35 (15 Aug 1970).

A theoretical calculation was made of the cross sections for the processes: $Li^+ + Li \rightarrow Li + Li^+$, $Li^+ + Na \rightarrow Li + Na^+$, using hydrogenic 2s traveling orbitals in a two-state approximation. It was found that the general outline of the results found by Rapp and Francis, using a very crude approximate model, remains unchanged in this more rigorous calculation. The main difference between the present results and those of Rapp and Francis is that the cross sections fall off more rapidly at velocities above 5×10^7 cm/sec when traveling orbitals are used. It may be concluded that nonresonant charge transfer does indeed behave like symmetric resonant charge transfer at velocities above that necessary to satisfy the adiabatic criterion $v = \Delta Ea/h$. (auth)

47037 EFFECT OF ELECTRON BINDING ON THE INCOHERENT SCATTERING OF GAMMA RAYS IN C, Al, AND Cu. Rao, V. S.; Parthasaradhi, K. (Andhra Univ., Waltair, India). J. Mines, Metal Fuels; 18: No. 3, 86-106(Mar 1970).

The effect of electron binding on the incoherent scattering of gamma rays in the energy region from 30 to 280 keV in elements C, Al, and Cu is estimated quantitatively. The theoretical and experimental ratios of bound-electron incoherent scattering cross sections to free-electron incoherent scattering cross sections are estimated. From the results it is concluded that the effect of electron binding on the incoherent scattering of gamma rays decreases as the energy increases and as the atomic number decreases. (INIS)

Atomic Theory

47038 (SC-RR-70-429) SOME RESULTS ON AUGER TRANSITION RATES INVOLVING f ELECTRONS. McGuire, Eugene J. (Sandia Labs., Albuquerque, N. Mex.). Aug 1970. 27p. Dep. CFSTI.

Expressions for the total Auger transition rate for an initial l_1 and final l_2 and l_3 = f holes are found, where l_1 and l_2 = s, p, d. Expressions are also found for the fine structure in Auger spectra for $l_1 = p,\bar{p}$, $l_2 = p,\bar{p}$, and $l_3 = f,\bar{f}$, in J–J coupling. Finally an expression is found for the summed fine structure, summed over j_2J and j_3. (auth)

47039 STUDY OF THE COMPTON PROFILE OF ATOMS AND MOLECULES OF THE FORM AHm. Naon, Michele; Cornille, Marguerite; Roux, Monique (CNRS, Paris). Compt. Rend., Ser. B; 270: 1026-8(20 Apr 1970). (In French).

The distribution of the momenta of the electrons in atoms was studied by expanding the atomic orbitals on a basis of gaussian orbitals. Relations between the mean values of r^m and p^m are obtained. (tr-auth) (France)

47040 EXTENSION OF THE DELTA-FUNCTION MODEL OF H_2^+: A POSSIBLE LABORATORY FOR STUDYING THEORIES OF EXCHANGE FORCES. Epstein, J. H.; Epstein, S. T.; Rosenthal, C. M. (Univ. of Wisconsin, Madison). Chem. Phys. Lett.; 6: 551-2(1 Sep 1970).

A small change is made in the delta-function model so as to give it more of the characteristics of H_2^+. The Eisenschitz–London–Hirschfelder–van der Avoird approximation is then tested on this model. (auth)

47041 VOPROSY KVANTOVOI TEORII ATOMOV. (Problems of Quantum Theory of Atoms). Pavinskii, P. P. (ed.). Leningrad; Izdatel'stvo Leningradskogo Universiteta (1970). 112p.

Four articles are included on quantum mechanics of many-electron atoms. The first article surveys the history of work done at Leningrad University on development of atomic theory and on mathematical methods for atomic calculations, including the self-consistent-field method. The applications of variational principles in atomic calculations and information on various actual problems are discussed in the second article. The third article is devoted to methods using hydrogen-like models for calculation of atomic and ionic energy levels. The use of the theory in calculations for multicharged ions of importance for plasma physics and space physics is stressed. The fourth article covers methods of electron correlation, in particular the so-called cluster method, that could be used in Hartree–Fock approximations. (R.V.J.)

47042 ELECTRON CORRELATION IN THE SPIN–SPIN INTERACTION FOR I^2. Gibbs, R. L. (Louisiana Polytechnic Inst., Ruston). J. Chem. Phys.; 53: 1385-7(15 Aug 1970).

A symmetric two-electron correlation function is coupled by tensor operator methods to the spin–spin Hamiltonian. The matrix elements in the JM representation are calculated using standard tensor operator techniques. The method is applied to the p^2 configuration with numerical results for the $2p^2\ ^3P$ state of helium included. (auth)

47043 HULTHEN TRANSFORM FUNCTIONS OF TWO-ELECTRON ATOMIC SYSTEMS. Yue, C. P. (National Research Council of Canada, Ottawa). J. Chem. Phys.; 53: 1470-4(15 Aug 1970).

Hulthèn-type functions are considered as special integral transform functions (Hulthèn transforms) and are used to approximate the ground-state closed-shell and open-shell and also the 2^1P excited-state wave functions of some two-electron atomic systems. The ground-state energies obtained are lower than those obtained with Slater functions. In contrast, for the 2^1P excited state, Slater functions give energies as good as Hulthèn transform functions. The (radial) Hulthèn transform of the 2p orbital gives a better energy for the 2^1P state than the 1p function suggested by Parr et al. (auth)

Cosmic Radiation

Refer also to abstracts 46967, 46968, 47104, and 47126.

47044 (INSJ-121) CALCULATION OF THE SIZE SPECTRUM OF HORIZONTAL AIR SHOWERS BY MONTE CARLO METHOD. Nagano, Motohiko (Tokyo Univ. (Japan). Inst. for Nuclear Study). Jun 1970. 34p. Dep. CFSTI (U. S. Sales Only).

The expected size spectrum of horizontal air showers by muons as parents is calculated by means of Monte Carlo method by taking into account the showers produced by photons due to bremsstrahlung of muons and by hadrons emitted in the muon–nucleon interactions. (auth)

47045 (UCRL-50880) STUDY OF THE TWO-STREAM INSTABILITY IN COLGATE'S SUPERNOVA MODEL OF COSMIC RAY ACCELERATION. McKee, Christopher F. (California Univ., Livermore. Lawrence Radiation Lab.). 26 May 1970. 101p. Dep. CFSTI.

Thesis. Submitted to Univ. of California, Berkeley.

This study consists of three parts: first, a nonrelativistic simulation of one-dimensional (1-d) counterstreaming plasmas;

second, theory and numerical experiment for 1-d relativistic counterstreaming plasmas; and third, the application of the results of the first two parts to Colgate's supernova model of cosmic-ray acceleration. The 1-d simulation model used in the first two parts involves integrating the relativistic equations of motion for up to 2^{15} plane charged sheets moving perpendicular to their faces under the influence of electrostatic forces only. In spite of the omission of radiation, the model is physically self-consistent. Both electron and ion sheets are included. The model simulates two infinite, homogeneous, counterstreaming plasmas of equal density moving with velocities $\pm v_0$; periodic boundary conditions are imposed. Collisional effects in the model are discussed in both the nonrelativistic and relativistic cases. (W.D.M.)

47046 ENERGY LOSS OF COSMIC RAYS IN THE INTERPLANETARY MEDIUM. Goldstein, M. L. (Univ. of Maryland, College Park); Fisk, L. A.; Ramaty, R. Phys. Rev. Lett.; 25: 832-5(21 Sep 1970).

The expansion of the solar wind is likely to cause low-energy cosmic-ray particles to lose a significant fraction of their energy in the interplanetary medium. It is shown that because of this effect, most of the protons observed below ~100 MeV and alpha particles below ~60 MeV/nucleon originate at higher energies, making it impossible to sample directly the interstellar spectra at these energies. (auth)

47047 ORIGIN OF LOW ENERGY COSMIC RAY POSITRONS AT ENERGIES <2 MeV. Burger, J. J.; Stephens, S. A.; Swanenburg, B. N. (Kamerlingh Onnes Laboratorium, Leiden). Astrophys. Space Sci.; 8: 20-8(Jul 1970).

It is shown that an appreciable flux of positrons below ~ a few MeV in the cosmic radiation could arise from the decay of cobalt nuclei in the decay chain $^{56}Ni \rightarrow {}^{56}Co \rightarrow {}^{56}Fe$, which occurs in the silicon burning shells of supernovae just after their ejection at relativistic velocities. The equilibrium spectrum of positrons in interstellar space was calculated on the assumption that the observed abundance of iron nuclei in cosmic radiation is the result of the above process. It was found that the observation below about 10 MeV can be well explained with a moderate acceleration of the positrons in the expanding envelope of supernovae prior to their propagation in the interstellar space. The total ^{56}Ni content in the shells of supernova necessary to account for the observed positrons was in agreement with that required to explain the peak luminosity during the supernova outburst. Since this model deals with positrons created at the time of injection of cosmic rays into the interstellar space, it becomes possible to study the shape of the injection spectrum of cosmic rays. (auth)

47048 SPONTANEOUS AND INDUCED CHERENKOV EMISSION IN A TURBULENT MEDIUM. Lerche, I. (Univ. of Chicago). Contract F-19628-69-C-0041. Astrophys. Space Sci.; 8: 29-49(Jul 1970).

It is shown that the presence of spatially random fluctuations in refractive index, about a mean exceeding unity, influences the power output of Cherenkov waves emitted by a charged particle in several ways. (1) The frequency spectrum of the spontaneous emission is altered by the fluctuations. (2) There is an induced Cherenkov emission due to the interaction of the spontaneous field with the random refractive index variations. This induced field can, in certain frequency bands, be as large as the spontaneous field. And it also contains a backscattered component that propagates in the opposite direction to the particle. (3) The conditions for emission of the Cherenkov waves, be they spontaneous or induced, depend critically on both the mean refractive index, the particle velocity, the intensity, and correlation length of the fluctuations. The dependence is sensitive to the precise functional form of the two-point correlation function. Instruments detect the optical Cherenkov emission produced by cosmic-ray particles penetrating the Earth's atmosphere (below about 5 km). Also, gas Cherenkov counters are triggered by the passage of highly energetic particles through the gas. Since both the Earth's lower atmosphere and the gas counters contain turbulent fluctuations, the present calculation is of some interest in connection with particle energy-loss mechanisms in turbulent media and the basic structure of such media. (auth)

47049 COMPOSITION OF LOW ENERGY PRIMARIES WITH $Z \geq 9$ IN COSMIC RADIATION. Dellien, U.; Soederstroem, K.; Kristiansson, K. (Univ. of Lund, Sweden). Astrophys. Space Sci.; 8: 74-85(Jul 1970).

Photometric mean track width measurements were made of 81 primary particles ($Z \geq 9$) stopping in a nuclear emulsion stack exposed to 2.7 g/cm² of residual atmosphere at Fort Churchill, Canada. The standard deviation of the charge determinations amounts to 0.14 units of charge for oxygen and increases to 0.40 units for iron nuclei when 10 mm track is measured. The relative abundances of the nuclei in the charge interval $8 \leq Z \leq 14$ are given for the energy interval 250 to 400 MeV/nucleon, and comparisons are performed with the results of other measurements. The VH particles are dominated by iron. The distribution of the VH particles seems to be consistent with the assumption that the VH nuclei have in the mean passed through only 1.6 ± 0.5 g/cm² interstellar matter. (auth)

47050 LIFETIME OF COSMIC RAYS IN THE GALAXY. Velinov, P. (Inst. of Geophysics, Sofia). Compt. Rend. Acad. Bulg. Sci.; 23: 477-80(1970).

The lifetime of cosmic rays T_0 in relation to ionization losses can be determined by a general expression representing the time in which the energy of the nucleus decreases from the initial value E_0 to E. The expressions derived are used for an evaluation of some parameters of cosmic rays in the Galaxy. (W.D.M.)

47051 HELIOCENTRIC Z GRADIENT IN PRIMARY COSMIC RAYS. Ely, John Thomas Anderson. Seattle; Univ. of Washington (1969). 140p. University Microfilms Order No. 70-8451. Thesis.

Cherenkov-scintillator particle telescopes designed to measure the charge and energy spectra of heavy primary cosmic rays were flown on OV1-10 and OV1-86. Three things were shown: (1) OV1-10 made an unambiguous measurement of charge in the range Z = 9 to 16 (F to S) above 5 BeV/n, which was probably the first satellite experiment to separate charge in this range of Z and E; (2) both OV1-10 and OV1-86 showed a latitude dependence of the Z spectrum; and (3) solar sector synchronous modulation. (Diss. Abstr. Int., B)

Direct Energy Conversion

47052 (AEC-tr-7161) MAGNETOPLASMADYNAMIC (MPD) CONVERTERS. Peschka, W.; Eitel, H.; Seeger, W. (Deutsche Versuchsanstalt fuer Luft- und Raumfahrt E. V., Stuttgart (West Germany)). Translation of Report DLR-FB-69-85. 72p. Dep. CFSTI.

Theoretical and experimental results on closed-cycle inductive MPD systems are given. Mercury vapor and argon are used as working fluids. Radiofrequency discharges were used for plasma generation. Cryopumping systems are used in the experimental setup with considerable success. Some ideas on the further development of the experimental work are given. (auth)

47053 (INR-1190) LEAKAGE CURRENTS IN AN MHD GENERATOR. Celinski, Z. (Institute of Nuclear Research, Warsaw (Poland)). 1970. 25p. Dep. CFSTI (U. S. Sales Only).

The effect of leakage currents on the MHD generator performance was analyzed. There are two main paths for the leakage currents: through the side insulating walls and through the generator casing. The poor performance of the experimental Hall generators is due to the leakage to the generator casing. If only leakage currents through the side walls are present, they deteriorate the output power in the Faraday generator more than in the Hall one. In the analysis, constant channel cross section, constant magnetic field, and constant gas parameters in the channel were assumed. (auth)

47054 (STI/PUB-191(Vol.1)) ELECTRICITY FROM MHD, 1968. VOLUME I. CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS. Proceedings Series. Proceedings of a Symposium on Magnetohydrodynamic Electrical Power Generation Held at Warsaw, 24-30 July 1968. (International Atomic Energy Agency, Vienna (Austria)). Nov 1968. 719p. (In several languages). (CONF-680704-(Vol.1)). IAEA $12.00.

Forty-six papers on closed-cycle MHD with gaseous working fluids are included in the following areas: diagnostics, steady-state nonequilibrium ionization, transient nonequilibrium ionization, pre-ionization and gas discharge, fields and flow in MHD channels, instabilities, and generator design and performance studies. (M.H.R.)

47055 (STI/PUB-191(Vol.2)) ELECTRICITY FROM MHD, 1968. VOLUME II. CLOSED-CYCLE MHD WITH GASEOUS WORKING FLUIDS. Proceedings Series. Proceedings of a Symposium on Magnetohydrodynamic Electrical Power Generation Held at Warsaw, 24-30 July 1968. (International Atomic Energy Agency, Vienna (Austria)). Nov 1968. 612p. (In several languages). (CONF-680704-(Vol.2)). IAEA $12.00.

Thirty-four papers on closed-cycle MHD with gaseous working fluids are included in the following areas: shock waves, power generation experiments, unconventional working fluids and concepts, and power plant concepts and economics. (M.H.R.)

47056 (STI/PUB-191(Vol.3)) ELECTRICITY FROM MHD, 1968. VOLUME III. CLOSED-CYCLE MHD WITH LIQUID-METAL WORKING FLUIDS. Proceedings Series. Proceedings of a Symposium on Magnetohydrodynamic Electrical Power Generation Held at Warsaw, 24-30 July 1968. (International Atomic Energy Agency, Vienna (Austria)). Nov 1968. 792p. (In several languages). (CONF-680704-(Vol.3)). IAEA $12.00.

Forty-one papers on closed-cycle MHD with liquid-metal working fluids are included in the following areas: diagnostics and fluid properties, fluid acceleration, MHD losses, generator design and performance studies, generator experiments, and power plant concepts and economics. (M.H.R.)

47057 (STI/PUB-191(Vol.4)) ELECTRICITY FROM MHD, 1968. VOLUME IV. OPEN-CYCLE MHD. Proceedings Series. Proceedings of a Symposium on Magnetohydrodynamic Electrical Power Generation Held at Warsaw, 24-30 July 1968. (International Atomic Energy Agency, Vienna (Austria)). Nov 1968. 759p. (In several languages). (CONF-680704-(Vol.4)). IAEA $12.00.

Forty-two papers on open-cycle MHD are included in the following areas: diagnostics and fluid properties, fields and flow in MHD channels, boundary layers, striated-flow MHD systems, generator design and performance studies, and power generation experiments. (M.H.R.)

47058 (STI-PUB-191(Vol.5)) ELECTRICITY FROM MHD, 1968. VOL. V. OPEN-CYCLE MHD. Proceedings Series. Proceedings of a Symposium on Magnetohydrodynamic Electrical Power Generation held at Warsaw, July 24-30, 1968. (International Atomic Energy Agency, Vienna (Austria)). Dec. 1968. 630p. (In several languages). (CONF-680704-(Vol.5)). IAEA: $12.00; Austrian Schillings 310,-; £5.0.0; F. Fr 58,80; DM 48,-.

Thirty-seven papers on open-cycle MHD are included in the following areas: power plant concepts and economics, electrodes and insulating materials, and auxiliary equipment (heat exchangers, combustion chambers, seeding techniques, magnets). (M.H.R.)

47059 (STI/PUB-191(Vol.6)) ELECTRICITY FROM MHD, 1968. VOLUME VI. INVITED LECTURE, RAPPORTEURS STATEMENTS AND DISCUSSIONS, ROUND TABLE DISCUSSIONS, INDEXES. Proceedings Series. Proceedings of a Symposium on Magnetohydrodynamic Electrical Power Generation Held at Warsaw, 24-30 July 1968. (International Atomic Energy Agency, Vienna (Austria)). Dec 1968. 499p. (In several languages). (CONF-680704-(Vol.6)). IAEA $12.00.

Included in this volume are: an invited lecture, Superconducting Magnets for MHD Generators, by Z. J. J. Stekly; the 25 rapporteur's statements with the ensuing discussions; and the three round table discussions. In this volume also are repeated the contents lists of the preceding five volumes to simplify referencing, and there are a list of participants, author and transliteration indexes, and a preprint symbol index. (M.H.R.)

47060 (UCRL-72487) MIRROR MACHINES AND DIRECT CONVERSION. Werner, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). 26 May 1970. 37p. (CONF-700614-2). Dep. CFSTI.

From Symposium on Fusion Reactor Design, Lubbock, Tex.

Direct conversion of fusion-reactor charged-particle energy to electrical form is discussed. The method of conversion, using a series of electrostatically focused collector electrodes, permits efficiencies in excess of 90%. The sources of charged particles are the "classical losses" in mirror machines, i.e., the loss of charged particles into the escape cone of the mirrors. (auth)

47061 IONIZED GAS-SOLID SUSPENSION IN AN ELECTRIC FIELD. Wu, Chih (Naval Academy, Annapolis). Energy Convers.; 10: 139-41(Jul 1970).

A study of the effect of thermionic emission of micron-sized solid particles in an ionized gas was undertaken. It was seen that, on the one hand, electron concentration in the ionized gas may be increased by emission from the solid particles; but on the other hand, the solid particles, depending on the material, may collect electrons. These results suggest that the introduction of solid particles into plasma provides a method for enhancing or suppressing the free-electron concentration at a given temperature. (auth) (UK)

47062 MHD POWER GENERATION: ENGINEERING ASPECTS. Womack, G. J. London; Chapman and Hall (1969). 160p. 60s.

The subjects discussed are: the basic theory of the electrical conductivity of gases, electrodynamics, MHD duct geometry, MHD power generation cycles, open-cycle MHD power generator plant components. (UK)

47063 LATEST RESULTS ON ARC ELECTRODES AND NOZZLE BLAST INSULATION. Mass, J.; Bouillard, J. G. (Electricite de France, Ecuelles). Rev. Gen. Therm.; 9: 905-20(Jul-Aug 1970). (In French).

Two new types of MHD nozzle structures i.e., arc electrodes and inert gas blast insulation, were recently studied by the Compagnie Générale d'Electricité and Electricité de France jointly with the Commissariat à l'Energie Atomique. Arc electrodes consist of a tip protected from the main flow by inert-gas scavenging and on which an electric arc appears that establishes a contact with the seeded gas. Tests made with these electrodes showed steady arc operating conditions even when perpendicular to the magnetic field. On the other hand, insulation of conducting plates with an air blast through a slot provided in the plates gave satisfactory results. A synthesis test was made with two arc electrode pairs insulated by means of an air blast. Furthermore the possibilities of application of such devices to industrial MHD generators were analyzed. (tr-auth) (France)

47064 GENERAL ANALYSIS OF AN OPTIMUM MHD GENERATOR WITH CONSTANT CROSS-SECTIONAL AREA OF THE CHANNEL. Pleshanov, A. S.; Lazarev, P. P. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 9-12(Oct-Dec 1969). (In Russian).

The analytical solution of the variational problem previously obtained in quasi-unidimensional approach at small magnetic Reynolds' numbers is studied for the optimization of the linear conductive MHD-generator with constant area of cross-section of the channel. In the diagram, the general parameter of MHD interaction-Mach number is considered in the initial channel cross section. It is shown that the work regimes of an MHD channel with shock waves are not optimum. The working substance is ideal, inviscid, non-heat-conducting gas with arbitrary electroconductivity. (tr-auth)

47065 MATHEMATICAL MODEL OF INDUCTION MHD MACHINES WITH SEPARATE MAGNETIC CIRCUITS. Birger, B. L.; Gorovits, V. S.; Kalnin, T. K.; Polmanis, Ya. E. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 78-82(Oct-Dec 1969). (In Russian).

The calculation of the field in induction MHD machines with separate magnetic circuits is given, using the assumption that the winding zone is considered as a continuous medium with electric and magnetic anisotropy. It is shown that the requirement of absence of field jump in neutral magnets in rotation along the magnetic line of force in a plane perpendicular to the wave motion of the field does not contradict the Maxwell laws, if one considers the finiteness of channel width. It is established that the average magnetic permeability in the direction of the traveling field has no effect on the field in the gap, but only acts on the resistive losses of the system. The operating flow in the gap, neglecting the saturation of the steel inductors, is distributed as in machines with standard magnetic systems. (tr-auth)

47066 TRANSVERSE EDGE EFFECT IN INDUCTION MHD MACHINES WITH HELICAL CHANNELS. Kirillov, I. R. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 111-16(Oct-Dec 1969). (In Russian).

On the assumption of the plane-parallel character of the electromagnetic field in the gap of an MHD machine with a helical channel, a problem is solved by the determination of the currents, forces, and power losses in liquid metal in a channel of finite width. Expressions are obtained and the calculated relations for the coefficient of the reaction of rotary currents and the coefficient of pressure attenuation and power losses are graphically represented. (tr-auth)

47067 WORKING REGIMES OF A CONDUCTION MHD CHANNEL WITH PARTIALLY ADJUSTED MAGNETIC AND ELECTRIC FIELDS WITH ASSIGNED NEUMANN BOUNDARY CONDITIONS. Zanders, Yu. K. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 117-26(Oct-Dec 1969). (In Russian).

Partially coordinated fields are understood to be those upon which magnetic induction fields are externally imposed proportional to the constituent current density of the applied potential and normal to the longitudinal axis of the channel. Expressions for electric potentials are obtained, from which the corresponding integral characteristics are calculated, for the consideration of the operation of the channel in generator and pump regimes. The characteristics of a channel with constant magnetic induction, which is imposed only on the inner electrode region of the channel, are cited for comparison. It is shown that it is analogous to an MHD channel without longitudinal end effects and in a channel with end effects it is important to estimate the value of the load factor k for the potential of the induced field. However, the use of the factor of the previous determination leads to the fact that at certain k values, change of regimes occurs along the length of the channel accompanied by power losses. The solutions of the Laplace and

Poisson equation are obtained by the method of separation of variables. (tr-auth)

47068 CRITERIA AND OPTIMIZATION METHODS OF MAGNETIC SYSTEMS OF MAGNETOHYDRODYNAMIC MACHINES. Kos'kin, Yu. P. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 127-34(Oct-Dec 1969). (In Russian).

It is proposed to use economy, weight, and size utilization factors as the criteria for comparison and optimization of the magnet systems of MHD machines. The economy factor is written in the form of the relation of the magnetic energy in the working gap to the power required for its creation. The weight and size utilization factors are obtained by the introduction in the economy factors of the weight and operating dimensions in the core of the magnet system. Expressions for the permeance of the dissipative flux obtained by the method of virtual magnetic flux lines and for the coupling between the magnetizing forces of the geometry of the magnetic circuit and the excitation coils are calculated. From these equations are obtained for the utilization factors of C-shaped, O-shaped, cylindrical, and coaxial magnetic systems and examples of their application are described. (tr-auth)

47069 PROBLEM OF FRICTION ON THE WALL OF AN MHD CHANNEL IN A CONSTANT MAGNETIC FIELD WITH VARIABLE ELECTRIC CONDUCTIVITY. Vyaz'menskii, B. E. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 140-1(Oct-Dec 1969). (In Russian).

In order to determine ways to increase the efficiency of the maritime MHD engine, it is important to know the fractional drag on the channel wall in the varying electroconductivity of the fluid. Previously, Kitaninym examined the boundary layer of the electroconductive fluid near the line of intersection of two surfaces in a transverse electromagnetic field and obtained a dimensionless formula for the coefficient of friction on a plate, when the strength of the magnetic field and the velocity of the incoming flow decline along the direction of motion x, i.e., where $H = x^{-1}$ and $u_\infty = x^{-1}$. From this, an expression is obtained for the coefficient of friction. (auth)

47070 THERMODYNAMICS OF BUILT-IN SINGLE-COMPONENT TWO-PHASE MHD GENERATORS. Vishnyakov, V. I.; Makarov, A. M.; Pavlov, K. B. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 27-30(Jul-Sep 1969). (In Russian).

A thermodynamic analysis of a built-in single-component two-phase MHD-generator is carried out through a one-dimensional approach in the absence of thermal and hydraulic losses in the apparatus circuit with even distribution along the length of the channel of the vaporous working substance. A characteristic of the operation of the generator is the participation of electromagnetic forces in the process of momentum transfer from vapor to liquid in the mixing of the respective flows. (tr-auth)

47071 PERIODIC EFFECTS IN A CONDUCTING SINGLE-PHASE MHD GENERATOR. Dvorchik, S. E. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 81-4(Jul-Sep 1969). (In Russian).

A self-excited conducting single-phase MHD generator of alternating current with an intermediate converter is studied. The application of one of the modifications of the method of Krylov–Bogolyubov equivalent linearization enables one to formulate and analyze the nonlinear equations for the buildup of oscillation. The hard and soft regimes of buildup of oscillations are studied, the steady states obtained, and their stability determined. The effect of the intermediate converter on the conditions for oscillations in the circuit is analyzed. (tr-auth)

47072 MULTIPHASE MHD GENERATORS WITH INDUCTIVE EXCITATION. Dvorchik, S. E. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 85-9(Jul-Sep 1969). (In Russian).

Self-excited conducting multiphase generators are studied. One of the modifications of the Krylov–Bogolyubov method of equivalent linearization is used for analysis of self-oscillating systems. The equation for buildup of oscillations is obtained. The equation for stabilization of the current amplitude of multiphase generators correct to constant coefficients agrees with the analogous equation for a single-phase generator. Criteria are introduced that determine the ratio of reactive to electric energy. It is shown that inductive excitation multiphase generators may be realized only for specific ratios of reactive to electric energy, i.e., the self-excitation of the generators studied is possible at a lower frequency than previously determined for this type of generator. (tr-auth)

47073 CALCULATION OF THE ELECTROMAGNETIC FIELD IN THE CHANNEL OF MODEL OF OPERATIONAL-TYPE MHD GENERATOR. Krishberg, R. R.; Germons, G. Ya. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 90-6(Jul-Sep 1969). (In Russian).

A model of the induction MHD generator is considered, where in the operating zone the channel cross section increases along the width according to the linear rule (the magnitude of the nonmagnetic gap constant), but beyond at the boundaries of the operating zones the channel cross section is constant. It is assumed that the velocity of the conducting fluid has only one component $v = Q/S$, where Q is the flow rate of the liquid, and S the channel cross section. The presence of superconducting short-circuiting lateral busbars is assumed. On the surface of the magnetic circuit with $\mu = \infty$ the discrete system of exciting currents is given. The Maxwell field equations are solved in the nonmagnetic gap. The expressions given may be used for calculations on MHD induction generators of the type studied. (tr-auth)

47074 APPLICATION OF GAS-DISPERSED MEDIA IN EGD GENERATORS. Belevtsev, A. T.; Muchnik, G. F.; Nesterov, V. A.; Rubashov, I. B. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 112-16(Jul-Sep 1969). (In Russian).

The problems of using aerosol media as EGD-generator working fluid to increase the efficiency are discussed. A new method for obtaining an aerosol working substance is described. The formation of aerosols by condensation during mixing in the fast flow of condensable fluids and "cold" gas proved efficient since it provided the necessary particle concentration and dimensions with low energy consumption. The experimental results of unipolar charge of dispersion media with high particle concentration in a corona discharge are examined. Data obtained with EGD-generator models operated with various gaseous dispersion media are given. (tr-auth)

47075 EFFECT OF METHOD OF AUTOMATIC REGULATION OF CONVERSION APPARATUS ON OPERATION OF FARADAY SECTIONED MHD GENERATORS. Kazachkov, Yu. A.; Shipulin, I. I. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 122-6(Jul-Sep 1969). (In Russian).

In the investigation of the nonnominal regimes of commercial MHD installations with steady current, it is necessary to consider real invertor volt–ampere characteristics, since they affect the work conditions of the main equipment. A comparison of three criteria of automatic invertor regulation (steadiness of current, of potential, and the coefficient of the electric load) was carried out on the basis of the qualitative analysis of the equation of the reversal of effects. (tr-auth)

47076 POSITIVE COLUMN OF ELECTRIC DISCHARGE IN CIRCULAR TRACK WITH TRAVELING MAGNETIC FIELD. Markovskii, N. V. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 132-4(Jul-Sep 1969). (In Russian).

The evacuation of a ring configuration with traveling magnetic field is described with conditions modeled after a synchronous magnetoplasmadynamic energy converter. Under pressures of 1- to 200-mm Hg of argon and with currents up to 20A, the steady synchronism of the movement of the positive column (current layer) with the traveling magnetic field is shown, i.e., the practicability of the induction MPD generator is shown. (tr-auth)

47077 EDDY CURRENTS IN AN INFINITELY FINELY SEGMENTED HALL GENERATOR. Jett, E. S.; Denzel, D. L.; Wu, Y. C. L. (Univ. of Tennessee, Tullahoma). Contract F44620-69-C-0031. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1592-7(Sep 1970).

The eddy currents in the cross-sectional plane of a conducting side wall Hall generator are studied. Fluid velocity and temperature effects are investigated by assuming two different types of flow, i.e., fully developed laminar flow and turbulent boundary-layer flow. The working fluid is a seeded combustion gas where the compositions were calculated by assuming chemical equilibrium. The electrical conductivity and Hall parameter are allowed to vary as functions of temperature and pressure, and their values are calculated, based on approximations formulated by Frost. Cold- and hot-channel wall conditions reveal quite different current distributions under laminar, fully developed flow conditions, with the cold wall distribution being much more nonuniform. Under turbulent boundary-layer flow conditions, however, cold and hot wall current distributions exhibit relatively minor differences, with both cases approaching the limiting case of constant velocity and electrical properties. Increasing the magnetic field strength and Hall parameter tends to increase the nonuniformity of the current distribution. The power output of the Hall generator is shown to depend strongly on the wall temperature under laminar, fully developed flow conditions, but this dependence is greatly reduced when the turbulent boundary-layer velocity profile is assumed. (auth)

47078 FUNDAMENTAL PHENOMENON OF MAGNETOHYDRODYNAMIC ENERGY CONVERSION. Csoerss, E. Acta Tech. Acad. Sci. Hung.; 65: No. 1-2, 43-55(1969).

The intensity of gas-dynamic forces acting on plasma components considering partial-pressure gradients and momentum-transfer probabilities gives basic relations for power design. (Fuel Abstr.)

47079 OPEN-CYCLE LOW-LOAD OPERATION OF COMBINED MHD-STEAM POWER PLANTS. Dinelli, G. (Ente Nazionale per l'Energie Elettrica, Latina, Italy). Bull. Dir. Etud. Rech., Ser. B; No. 1, 65-80(1970). (In French).

Low-load performance of a combined MHD-steam power plant in open-cycle operation is evaluated for a series-type MHD generator with a single outside load. Optimal operating methods are established for various loads, based on the assumption that the conventional system components, i.e., compressor, combustion chamber, heat exchanger, and steam turbine, are sufficiently flexible not to restrict operation of the MHD generator. The fall-off in overall cycle efficiency at 50% of the rated plant output can be limited to less than 2%, provided the reduction in electrical power output is accompanied by a reduction in fuel oil flow while maintaining a constant combustion mixture and potassium seeding rate. Low-load operation, however, increases the gas temperature and reduces the MHD duct terminal voltage, and it is preferable, therefore, to slightly increase the combustion air flow with respect to the stoichiometric quantity. In view of the combustion chamber pressure and air flow variations with load, it is considered advisable to use variable-speed compressors driven by auxiliary turbines. (tr-auth) (France)

Fluid Physics

Refer also to abstracts 47054–47059.

47080 (NP-18419) HYDROMAGNETIC WAVE PROPAGATION IN INHOMOGENEOUS MAGNETIC FIELDS. Lehane, J. A.; Paoloni, F. J. (Sydney Univ. (Australia). School of Physics). 1970. 22p. (ER-81). Dep. CFSTI (U. S. Sales Only).

Results are presented for torsional waves propagating into magnetic beaches and compressional waves into magnetic cliffs. The inhomogeneous field used consisted of two uniform fields of different magnitude connected by a transition region the length of which could be changed. Attention was concentrated on looking for a wave reflected from the field discontinuity. For torsional waves no reflected wave was detected either for waves of frequency much less than ion cyclotron frequency or for those which encountered ion cyclotron resonance in the low-field region. For compressional waves reflection was observed under some conditions. It was most pronounced when the length of the transition region was not appreciably greater than the wave attenuation length and when the wave was cut off in the high-field region. Values of the reflection coefficient and the phase change at reflection are given. (auth) (Australia)

47081 (UTIAS-150) APPROXIMATION TO THE RADIATIVE TRANSPORT OF ENERGY IN AN OPTICALLY THICK LINE. Gilpin, R. R. (Toronto Univ. (Ontario). Inst. for Aerospace Studies). Jan 1970. 22p. Dep. CFSTI (U. S. Sales Only).

The radiative transport of energy in an optically thick line is studied. First, an asymptotic expansion for the radiative kernel is obtained for a Lorentz line shape. This result is used to calculate the radiative transport in some problems of interest in MHD gases. The limits of applicability of this asymptotic expansion are then determined by considering such effects as line overlap and statistical broadening. (auth)

47082 ONE-DIMENSIONAL PARTICULATE ELECTROGASDYNAMICS. Trezek, George J.; France, David M. (Univ. of California, Berkeley). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1386-91(Aug 1970).

A theoretical analysis of a two-phase particulate electrogasdynamic flow is presented. The effect of the space charge induced electric field force on the solid particle charge carrier is included. The direct conversion of kinetic energy into electricity is accounted for by the electrical body force work term in the energy equation. A sample solution to the seven, ordinary, nonlinear, coupled, differential equations is presented for a typical electrogasdynamic energy conversion channel, L/D = 13. Results for the axial pressure, electric current, and potential distribution are given, as well as particulate and gas phase velocities and temperatures for 100 μ diameter particles at two mass-loading ratios of $M_p^* = 0.1$ and $M_p^* = 1.0$. (auth)

47083 STEADY ROTATION OF A CONDUCTING SPHERE IN A VISCOUS CONDUCTING LIQUID. Ranger, K. B. (Univ. of Toronto). J. Phys. Soc. Jap.; 29: 775-7(Sep 1970).

A magnetized conducting sphere is rotating with steady angular velocity in a conducting viscous liquid at rest at infinity. The sphere is magnetized by a dipole field located at its center and directed perpendicular to the axis of rotation. On the assumption that the three hydromagnetic parameters are small, the asymmetric perturbations of the Stokes flow are calculated for the fluid velocity and induced magnetic field. An expression is found for the couple on the sphere in terms of the Hartmann number M. (auth)

47084 ELECTROMAGNETODYNAMIC STABILITY OF VISCOUS FLUID CYLINDERS. Bhowmik, Gita; Talwar, S. P. (Univ. of Delhi). Progr. Theor. Phys. (Kyoto); 43: 1413-22(Jun 1970).

The influence of viscous forces on the gravitational and capillary instability of liquid cylinders carrying a uniform axial magnetic field is investigated. The stability of a cylinder of dielectric viscous liquid with an axial electric field is also studied. It is found that viscosity has a stabilizing influence, as the magnetic field or the electric field has, but when the viscous force acts solely it only reduces the growth rates of the unstable modes without affecting the critical size of breakup of the cylinder. Further, as against the case of a field-free viscous cylinder, it is found that, in the presence of magnetic field, the critical size of breakup is increased with an increase in the gravitational (or the capillary) parameter and the extent of increase, however, decreases to zero in the limit of zero magnetic field. (auth)

47085 FLOW OF NONHOMOGENEOUS CONDUCTING GAS IN A TRANSVERSE MAGNETIC FIELD. Zimin, E. P.; Eismont, O. A. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 13-23(Oct-Dec 1969). (In Russian).

The quasi-unidimensional steady-stream flow, formed by alternating heterogeneous layers of inviscid nonheat-conducting gas in transverse magnetic and electric fields is examined. It is shown that, in the case of high density, the layer sequence of the flow considered can be described by the usual system of magnetohydrodynamics, but with a certain effective conductivity. The optimization of the effective conductivity is conducted, and it is found that the maximum of its excess over the conductivity corresponding to the same average flow temperature is of practical interest if the range of temperatures occurs in the relatively small mass of the more heated layer. For a similar case, i.e., in the small relative mass of one of the layers when the other is nonconducting, the solution of the initial system of equations is obtained, and the qualitative contrasts of lamellar with homogeneous streams are analyzed. (tr-auth)

47086 VORTEX MOTION OF AN ELECTROCONDUCTIVE GAS BETWEEN PERMEABLE CYLINDERS WITH HALL EFFECT. Yakhot, A. O. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 29-34(Oct-Dec 1969). (In Russian).

The steady radially turbulent flow of a compressible electroconductive gas between two coaxial cylinders of constant height is considered, given the axial magnetic field and the Hall effect. Gas is supplied through the internal electrode of radius R_1 and is removed through the external electrode of radius R_2. Upon the premise that the movement is axially symmetric, the magnetic Reynolds number small, and disregarding the variations of magnitude along the Z axis coinciding with the cylinder axes, the problem reduces to the numerical integration of equations for radial velocity v and pressure p. The radial velocity component determines the effect of in-channel cutoff when the continuity of gasdynamic magnitudes is violated. This work shows that the channel length, inside which cutoff does not occur, is limited upon approaching infinite Mach number at the intake. A qualitative analysis of the flow in the beginning of the channel is conducted and on the basis of derived relations a diagram characteristic of the different flow regimes is constructed. Certain numerical results are given in graphical form. (tr-auth)

47087 ONE CLASS OF ACCURATE SOLUTIONS IN MAGNETOHYDRODYNAMICS. Shcherbinin, E. V. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 46-58(Oct-Dec 1969). (In Russian).

In 1961 Vu published work which showed the existence in magnetohydrodynamics of a class of exact solutions analogous to the Yatseeva-Skvaira exact solutions in usual hydrodynamics. Vu proved this analysis for the two-dimensional assignment of field velocity and magnetic field in spherical coordinates. In the present work the class of exact solutions is extended at the expense of including for analysis a third azimuthal magnetic field component. However, the main effort is devoted to the two-dimensional case for which the order of the new solutions is obtained. In particular, for a fluid of great conductivity, the rare effect of flow intensification with superposition of magnetic field is detected slightly. (tr-auth)

47088 ACCURATE SOLUTIONS OF THE NAVIER-STOKES EQUATIONS IN MAGNETOHYDRODYNAMICS. Shilova, E. I.;

Shcherbinin, E. V. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 59-64(Oct-Dec 1969). (In Russian).

Two problems from the class of exact solutions of the equations of Navier–Stokes–Maxwell in the spherical coordinate system, which describe the flow of conducting fluid in an azimuthal magnetic field are examined. The first is the MHD analog of the Landau jet; the second is the MHD analog of the Skvaira jet. Both problems are solved in a noninductive approach where $Re_m \ll 1$. The solutions obtained show that near the axis of symmetry the azimuthal magnetic field focuses the jet. (tr-auth)

47089 CALCULATION OF SUPPRESSION OF TURBULENCE IN MAGNETOHYDRODYNAMIC PROBLEMS. Pleshanov, A. S. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 4, 65-70(Oct-Dec 1969). (In Russian).

On the assumption of arbitrary dependence of the ratio of the width of the mixing zones to the scale of the transverse coordinate of the variable parameter of the MHD interaction, eleven problems are solved on the theory of free turbulence in an incompressible conducting fluid in longitudinal and transverse magnetic fields, with the absence of electric field and small magnetic Reynolds numbers. The effect of turbulence suppression is described by decreasing the dependence of this relation on the argument proportional to the induction of the magnetic field. In a general form, the influence of this effect on the characteristics of the flows is examined. A possible form of the function that describes the effect of turbulence suppression is discussed. Also, two problems of the theory of peripheral turbulence in a magnetic field are described. (tr-auth)

47090 UNSTEADY ONE-DIMENSIONAL MOTIONS IN MAGNETOHYDRODYNAMICS IN CONSTANT FIELD OF GRAVITY. Dzhuzumkulov, T. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 134-7(Jul-Sep 1969). (In Russian).

Unsteady one-dimensional motion in magnetohydrodynamics is considered by calculation of the gravity field. The singular solution and Riemann invariants are obtained for the case of ideal conductivity. (tr-auth)

47091 MHD BOUNDARY LAYER AT DISKS ROTATING IN HOMOGENEOUS AXIAL FLOWS. Gorbachev, L. P.; Potanin, E. P. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 137-9(Jul-Sep 1969). (In Russian).

An MHD boundary layer in a homogeneous external magnetic field directed perpendicularly to the plane of a disk is examined. The induced magnetic field is not taken into account. The solution is derived by a method partially considering the inertial terms. Data obtained are correlated with published data. (tr-auth)

47092 UNSTEADY MAGNETOHYDRODYNAMIC FLOWS IN CHANNELS. Ryabinin, A. G.; Khozhainov, A. I. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 3-7(Jul-Sep 1969). (In Russian).

A survey is given of articles available in the world literature on the theoretical and experimental studies of unsteady flow of viscous incompressible conducting fluids in magnetohydrodynamic channels. The analysis of the main results is shown. The most important directions for further searches were formulated. (tr-auth)

47093 PARAMETRIC EXCITATION OF INSTABILITY OF A FLUID IN MAGNETIC AND ELECTRIC FIELDS. Briskman, V. A.; Shaidurov, G. F. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 15-19(Jul-Sep 1969). (In Russian).

The problem of equilibrium stability or the flow of an incompressible viscous fluid in electric and magnetic fields given the variations in time of the parameters is discussed. As typical examples, problems are cited in which the system has intrinsic oscillations and the modulation of parameters causes paramagnetic resonance: the equilibrium stability of the fluid surface in an electric field, in crossed electric and magnetic fields, and convective instability in magnetic fields. The formulation of the problems and the results of the investigation are presented. Periodic change of the field strengths or the temperature gradient causes the modulation of the natural frequency. Parametric instability emerges with modulation amplitudes great enough for complete energy dissipation. The conditions for the onset of instability were found by the method of expansion of the solution at small modulation amplitude. Certain theoretical results are compared with experiments. (tr-auth)

47094 UNSTEADY FLOW OF PLASMA IN MAGNETOGASDYNAMIC SHOCK-TUBE CHANNELS. Genkin, A. L.; Kudryashova, L. A.; Sukhov, G. S. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 20-6(Jul-Sep 1969). (In Russian).

The method of solution of the unsteady flow is presented, and the results of numerical calculations are given on the entry of the plasma clusters in the wake of the supersonic flow of electroconductive gas, moving behind the shock wave front, in a channel of constant cross section with continuous electrodes connected through ohmic resistance. The conditions for formation of second-order discontinuities—the shock compression in the plasma clusters—are indicated. (tr-auth)

47095 EXCITATION OF MAGNETIC FIELDS BY A SYSTEM FLOODING JETS. Gailitic, A. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 31-7(Jul-Sep 1969). (In Russian).

It is shown that in an electrically homogeneous fluid conductor the motion of three or more nonintersecting jets can create a magnetic field. The magnetic Reynolds numbers necessary for self-excitation are calculated. (tr-auth)

47096 ELECTROMAGNETIC FORCES IN CONDUCTING FLUIDS IN PRESENCE OF CROSSED ELECTRIC AND MAGNETIC FIELDS. Chekin, B. V.; Shchelukhin, E. M. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 38-42(Jul-Sep 1969). (In Russian).

Electromagnetic forces are considered in a conducting fluid in a vessel of rectangular cross section with nonconducting walls, in the presence of crossed electric and magnetic fields. The magnetic field is assumed homogeneous or varying according to a given law. The electric current is introduced through the walls with electrodes of finite dimensions and distributed evenly along their surface. Analytical expressions are obtained for the potential distribution in the two- and three-dimensional cases, under the indicated conditions, and assuming small magnetic Reynolds numbers, as well as a magnetic field of applied and induced currents. (tr-auth)

47097 UNSTEADY FLOW OF WEAKLY CONDUCTING FLUIDS CREATED BY THE ROTATION OF DISKS. Sharikadze, D. V. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 43-6(Jul-Sep 1969). (In Russian).

The nonuniform rotation of an infinite flat disk in a weakly conducting fluid is considered theoretically with the calculation of the applied magnetic field. The boundary problem for the nonlinear equation is reduced to a system of equations of the Volterra-II type that may be resolved in the form of a converging series by successive approximations. The results obtained show that the magnitude of the moment of resistance of the disks depends on the magnetic field in the first approximation and the calculation in the second approximation has no effect on this quantity. (tr-auth)

47098 CALCULATION OF LAMINAR FLOW OF ELECTROCONDUCTING FLUIDS BETWEEN PARALLEL SURFACES IN TRAVELING MAGNETIC FIELD. Petrovich, R. A.; Ulmanis, L. Ya. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 57-62 (Jul-Sep 1969). (In Russian).

The calculation of laminar flow of electroconducting fluids between parallel surfaces in a traveling magnetic field is examined. The analysis of the results obtained is given and a comparison is made with calculations in the electrodynamic approach. The system of nonlinear differential equations of Maxwell and Navier–Stokes is integrated with iterations according to the correlation method. The slip and magnetic field distribution along the cross section of the channel are obtained. The average slip along the channel cross section, the dependence of the mean relative force on the parameter ϵ, and the relation of the product of the Reynolds and Batchelor numbers to the modified Hartmann number R are calculated. The algorithm of the calculation is given. (tr-auth)

47099 VOLT–AMPERE CHARACTERISTICS OF MHD GENERATOR WITH FIXED DIRECTION OF ELECTRIC FIELD AND ONE LOAD. El'kin, A. I.; Yantovskii, E. I. Magn. Gidrodin., Akad. Nauk Lat. SSR; No. 3, 74-80(Jul-Sep 1969). (In Russian).

In a quasi-one-dimensional approach the volt-ampere characteristics of an MHD-generator with fixed electric field direction are considered, i.e., with a closed channel and single charge in the absence of longitudinal current in the nominal regime. Calculations performed on the 3VM (Urals-4) show that besides shock-free flow regimes in the MHD channel (Regime I) flows are possible with shock waves in the channel of the MHD generator (Regime II) or in the nozzle (Regime III). Volt-ampere characteristics are constructed for each of the possible regimes. It is shown, that the volt–ampere characteristics of regime I are nonlinear, and their slope at the reference point increases with the increase of the MHD interaction parameter. In contrast to flow in ducts with friction, the maximum channel length (corresponding to the sound velocity at exit) in the presence of shock waves in the channel or nozzle can be less than the maximum length in shock-free flow. The volt–ampere characteristics of regimes I and II can be constructed only by currents greater than a certain mini-

mum. To this current corresponds shock-free flow with thermodynamic cutoff in efficiency from channel. For Regime III, such a limitation does not exist. (tr-auth)

47100 MHD COUETTE FLOW IN SLIP-FLOW REGIME WITH UNIFORM SUCTION AT STATIONARY PLATE. Soundalgekar, V. M.; Haldavnekar, D. D. Stud. Univ. Babes-Bolyai, Ser. Phys.; 15: 25-38(1970).

The effects of a transverse magnetic field for a two-dimensional case were studied. Induced magnetic field is neglected and the modified Navier–Stokes equations are reduced to third- and second-order nonlinear equations. Expressions are derived for the axial and transverse components of velocity, axial pressure difference, skin-friction coefficient, velocity gradient at the upper wall, and the mass flow coefficient to $0(\lambda)$, where λ is the suction Reynolds number assumed $\ll 1$. Results are presented and discussed. (M.O.W.)

Geophysics (Upper Atmosphere)

Refer also to abstracts 46936, 46948, 46978, 47216, and 47289.

47101 (NP-18421) NEUTRAL GAS EFFECTS ON COSMICAL PLASMAS. Lehnert, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Aug 1969. 14p. Dep. CFSTI (U. S. Sales Only).

Some effects of neutral gas interaction taking place in cosmical plasmas in the presence of a magnetic field are considered. Inhomogeneous states are studied where there are limited regions of fully ionized plasma being bounded by regions of neutral or lowly ionized matter. The fully ionized plasmas will interact with the surrounding neutral gas through partially ionized boundary regions, in a way which strongly depends on an immersed magnetic field. On account of the neutral gas interaction, a minimum power input and temperature exist below which the fully ionized plasma cannot be sustained. This limit is sharply defined and should produce abrupt appearances or disappearances of cosmical phenomena under certain conditions. It is shown that the fully ionized plasma cannot be sustained in a stationary or quasi-stationary state, unless the power input and the temperature are kept above a certain minimum level. Since this level is sharply defined, it should be associated with the sudden appearance and disappearance of certain fully ionized plasma phenomena. A situation is also described where the fully ionized plasma and the neutral gas consist of several elements or isotopes. The diffusion across the magnetic field in the boundary regions should give rise to a considerable degree of element separation. This mechanism may account for the observed abundance anomalies in magnetic stars and in the solar wind. Further investigations on this problem are suggested. (auth) (Sweden)

47102 EFFECTS OF THE EARTH'S DAILY ROTATION ON ELECTRIC CURRENTS IN THE MAGNETOSPHERE. Mishin, Vilen M. (Siberian Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Irkutsk, USSR). Beitr. Geophys.; 78: 300-8(1969).

Due to the noncoincidence of the Earth's rotational axis and magnetic dipole axis the daily changes of the electric conductivity tensor are not in phase for the northern and southern ionosphere. Therefore, the electric currents, being not symmetrical with respect to the magnetic equator, are flowing partly through the magnetosphere along the lines of the magnetic field ("longitudinal currents"). It is assumed that the magnetic field of these longitudinal currents will be compensated on the Earth's surface by Pedersen currents flowing in the dynamo region. Approximate computations lead to the result that an increasing ionization within the E-region and other observed ionospheric phenomena, for quiet as well as for disturbed days, may be explained by these longitudinal currents. (auth)

47103 HARMONIC ANALYSIS OF Sq. Fanselau, Gerhard (Deutsche Akademie der Wissenschaften zu Berlin, Potsdam, Ger.). Beitr. Geophys.; 78: 27-40(1969). (In German).

Typical Sq-variations are harmonically analyzed with respect to time intervals centered at noon. There exist time intervals for optimal values of c_1, c_3, c_5. The parameters responsible for the modulated part of Sq are defined and their dependence on seasons and sunspot number is numerically calculated. (auth)

47104 MORFOLOGIYA SPOKOINOI I VOZMUSHCHENNOI IONOSFERY. (Morphology of Quiet and Perturbed Ionosphere). Rudina, M. P. (ed.). Trudy Sektora Ionosfery, Volume I. Alma-Ata, USSR; Izdatel'stvo Nauka Kazakhskoi SSR (1970). 172p.

Twenty-eight articles are included on ionospheric investigations conducted at Kazakhstan during 1964 to 1967. Ionospheric investigations are reported that were conducted in the Kazakhstan Region during the IQSY. Equipment designed for studying the mechanism of ionospheric propagation of radio waves is described. Computed and experimental data are compared. A new method for analyzing variations of cosmic radiation is proposed. (tr-auth)

47105 ELECTRON ACCELERATION ASSOCIATED WITH STRONG HYDROMAGNETIC WAVES IN A COLLISIONLESS PLASMA. Hasdal, John Allan. Denver; Univ. of Denver (1969). 105p. University Microfilms Order No. 70-7530.

Thesis.

The measurement of low-energy (1 to 3 eV) thermal electrons and 100- to 2000-eV electrons in the magnetosphere implies that acceleration mechanisms are operating. The plasma and magnetic field of the solar wind and the magnetosphere are shown to be described by macroscopic moment (fluid) equations. From these equations Adlam and Allen have derived a stationary solution describing a solitary wave. It was found that the fields of this wave act irreversibly upon electrons of initially greater than thermal energies—an acceleration. The accelerations produce a peak in an energy distribution, which is interpreted as a means to increase the average energy of the distribution. This can be related to the existence of a thermal plasma (1 to 3 eV) in the magnetosphere. Energies to 2 keV are also available from the effects of the wave motion, and are related to the electrons (100 to 2000 eV) found in the plasma sheet of the magnetosphere. An initial value problem related to the stationary wave solution shows that the magnetopause is a likely region for the generation of these waves. (Diss. Abstr. Int., B)

47106 EXCITATION RATE OF SODIUM D LINE IN THE NIGHTGLOW. Srivastava, A. N.; Shukla, R. V. (Univ. of Allahabad, India). Astrophys. Space Sci.; 8: 136-9(Jul 1970).

The processes responsible for the emission of the sodium D line in the Earth's atmosphere and the laboratory are briefly reviewed. From the laboratory results of Ghosh et al. (1970), the rate coefficient of reactions exciting sodium D line is estimated to be 4.73×10^{-25} cm^3/sec^2, and its intensity in the nightglow is found to be about 114 R in summer and 302 R in winter. (auth)

47107 EVALUATION OF CERTAIN MAGNETOSPHERE PARAMETERS BEGINNING WITH THE PROPERTIES OF IRREGULAR HYDROMAGNETIC PULSATIONS (SIP AND IPDP). Lacourly, S. (CNET, Issy-les-Moulineaux, France). Ann. Geophys.; 25: 651-7(1969). (In French).

The very pronounced repetitive characteristics of SIP led to a search for a possible period of repetition. An attempt is made to relate this period to the dimensions of the magnetospheric cavity. IPDP's being related to the disconnection of magnetic field lines on the night side of the Earth, and therefore to the moving of the plasmapause, can result in the calculation of the electric field in the part of the magnetosphere where these emissions are generated. (auth)

47108 PEARL MICROPULSATIONS OF 3 TO 5 SECONDS OBSERVED IN PRESENCE OF X RADIATION. Troitlhou, J.-P.; Laffont, J. (Centre d'Etude Spatiale des Rayonnements, Toulouse). Ann. Geophys.; 25: 647-50(1969). (In French).

Magnetic pearl-like micropulsations are observed with x-ray precipitation in the auroral zone. Both phenomena are evaluated with a constant delay time of about 6 minutes. (tr-auth)

47109 STUDY OF DOPPLER-SHIFTED CYCLOTRON RADIATION FROM ENERGETIC ELECTRONS IN THE MAGNETOSPHERE. III. Singh, R. P.; Singh, R. N. (Banaras Hindu Univ., India). Ann. Geophys.; 25: 639-45(1969).

Doppler-shifted cyclotron radiation has been considered previously as a source of vlf emission from the magnetosphere. The power radiated by an energetic electron spiraling along the geomagnetic lines of force is calculated here. The total power at 10, 30, and 50 kc is calculated, and it is seen that the total power is radiated before the electron reaches the mirroring point. Angular distribution of normal and anomalous Doppler-shifted cyclotron power is calculated and shown by polar diagram. The calculated total power falls short of experimentally observed vlf power. The significance of coherent radiation and some bunching mechanism has been discussed. (auth)

47110 STUDY OF CHERENKOV RADIATION FROM ELECTRONS IN THE MAGNETOSPHERE AND IONOSPHERE. II. Singh, R. N.; Singh, R. P. (Banaras Hindu Univ., India). Ann. Geophys.; 25: 629-38(1969).

The theory of Cherenkov radiation from the electrons in the magnetosphere is discussed. The total Cherenkov power radiated by these electrons for certain frequency range and variation of the total Cherenkov power along the lines of force at different heights was calculated. The radiated power from the equatorial region is found to be minimum and increases with increasing latitudes, with a maximum in the auroral zone. The integrated

Cherenkov power at a fixed frequency, to be received at a point was determined. Obtained spectral power density is compared with various available measurements of vlf wave power. The observation of vlf waves in the low-altitude equatorial region is discussed. It is argued that the coherent radiation due to electron influx bunching increases the radiated power. (auth)

47111 POTENTIAL CREATED BY A POINT SOURCE OF DIRECT CURRENT IN THE IONOSPHERE. Chasseriaux, J.-M. (Groupe de Recherches Ionospheriques, Saint-Maur, France). Ann. Geophys.; 25: 609-28(1969). (In French).

A method was developed for calculating the potential created by a point source of direct current in the ionosphere at high and medium geomagnetic latitudes. It takes into account the anisotropy of the electrical conductivity as well as its variation with altitude. It is shown that when the transverse conductivity is small compared with the longitudinal conductivity, to the first approximation the equipotential surfaces are coaxial cylinders whose axis is the magnetic field line that passes through the source, and that, in general, the effect of the inhomogeneity of the ionosphere becomes significant only at distances greater than a few meters from this field line. (tr-auth)

47112 SPREAD-F ECHOES AT AHMEDABAD OVER A SOLAR CYCLE. Rastogi, R. G.; Kulkarni, P. P. (Physical Research Lab., Ahmedabad, India). Ann. Geophys.; 25: 577-87(1969).

The most common types of spread-F echoes observed at Ahmedabad are the range-splitting type occurring generally during maximum sunspot years and the frequency-splitting type occurring generally during minimum sunspot years. The nocturnal variation of spread-F occurrence showed a single peak during the minimum and moderate sunspot years at 02 hr and 22 and 23 hr, respectively, while during maximum sunspot years there occurred two peaks at 23 hr and 04 hr with a minimum between these. The seasonal variation of spread-F occurrence during the maximum sunspot years showed two almost equal peaks at the equinoxes, but during the minimum sunspot years there was a major peak at June and July and another minor one during January. The increase of solar activity decreased the annual average probability of spread-F occurrence, the effect being most pronounced for the summer months. An increase of magnetic activity decreased the occurrence of spread-F during any of the seasons of high sunspot years and during the summer of low sunspot years. The solar time of maximum spread was delayed a few hours during the magnetically disturbed than the quiet days. The nocturnal variation of spread-F index had the maximum value at the time when h'F was rapidly decreasing with time. The characteristic features and the variations of spread-F occurrence at Ahmedabad are different from those at the equatorial stations. (auth)

47113 METHOD OF SOLUTION OF THE F_1 LAYER NONLINEAR IONOSPHERIC CONTINUITY EQUATION AND THE EARLY MORNING AND LATE EVENING INCREASE IN ELECTRON DENSITY OBSERVED AT SOME STATIONS. Torr, D. G.; Torr, Marsha R. (SACSIR, Johannesburg). Ann. Geophys.; 25: 571-5(1969).

The extent to which time variations in loss and production processes are responsible for the midday biteout effect in electron density observed at many stations is investigated. A method is described for solving the nonlinear differential ionospheric continuity that arises from consideration of production and both linear and nonlinear recombination-type loss processes. The calculations are done for a high- and middle-latitude station, and it is shown that the basic shape of the midday biteout could be caused by chemical processes, if the shape is not radically altered by plasma diffusion. Essentially, loss lags behind production at sunrise; this produces the early morning peak in electron density. With the diurnal expansion of the atmosphere, loss overtakes production at about 08 hour to produce a decrease in electron density during the day. Diurnal contraction of the atmosphere at sunset can decrease loss sufficiently to produce a slight increase in electron density. (auth)

47114 INTERACTION BETWEEN NEUTRAL GAS AND IONIZATION IN THE F REGION DURING THE PASSAGE OF ATMOSPHERIC GRAVITY WAVES. Klostermeyer, J. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Ann. Geophys.; 25: 547-50(1969).

Atmospheric gravity waves in the F region act upon the ionization and can thus be detected by means of electron density profiles. It is possible to get a first approximation for the motion of the ion and the electron gas, if the electron density profiles are suitably normalized. On the other hand the ionization reacts upon the motion of the neutral gas generating ohmic losses. In the vicinity of the F-layer maximum, these losses are almost entirely responsible for the attenuation of the observed gravity waves. (auth)

47115 GRAVITY WAVES IN THE THERMOSPHERE. Testud, J.; Vasseur, G. (CNET-RSR, Issy-les-Moulineaux, France). Ann. Geophys.; 25: 525-46(1969). (In French).

Some observations of the F region, using the Saint-Santin-Nançay Thomson scatter facility, were carried out on September 13th, 1967 during a strong magnetic storm. Large oscillations, featuring a two-hour period, were observed on electron density and temperature, and also ion temperature and velocity. The various characteristics of the observed phenomena interpreted according to the theory of internal gravity waves include phase variation in the horizontal and vertical directions, phase relations between various parameters, and height variation of the wave amplitude. The agreement with the theory of free internal gravity waves is found to be rather satisfactory. However, some discrepancies including viscous damping, ionic dissipation, and partial ducting are discussed. A good correlation can be shown between strong magnetic activity and the presence of such waves. This seems to confirm the important part of gravity waves in the thermospheric heating during magnetically disturbed periods. (tr-auth)

47116 INFLUENCE OF THE ATMOSPHERIC TEMPERATURE ON THE ELECTRON DENSITY DISTRIBUTION IN THE MIDNIGHT F REGION. Ruester, R. (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). Ann. Geophys.; 25: 499-503(1969).

The system of partial differential equations describing the behavior of the nighttime F-layer embedded in the neutral atmosphere under the influence of gravity, diffusion, viscosity, external mechanical and electromagnetic forces is solved numerically under additional assumptions. Among other things the results allow one to derive a numerical relation between the curvature of the F-layer profile at the peak and the temperature of the neutral gas there. This relation is in good agreement with the observed results. (auth)

47117 LATITUDE DISTRIBUTION OF NIGHT AIRGLOW. Sharp, W. E.; Rees, M. H. (Univ. of Colorado, Boulder). J. Geophys. Res.; 75: 4894-6(1 Sep 1970).

Data from instruments aboard a Convair 990 aircraft in 1968 were taken for measurements of nightglow radiations at low and middle latitudes and polar cap zones. During these airglow flights the Herzberg I system of O_2 in the near ultraviolet and the [O I] 5577-A line were recorded. The data points for 5577-A were averaged every 5° of invariant latitude south of 60°, and every 2½° north of 72.5°. The data points for the Herzberg bands were averaged every 2½° for all latitudes. It is concluded that, on the average, the 5577-A data and Herzberg I emissions are constant with latitude. There is no discernible trend in the data, collectively or for individual nights. The nature of the experiment precluded reliable separation between temporal and spatial effects. (J.C.W.)

47118 RECENT OCCURRENCES OF STABLE AURORAL RED ARCS. Marovich, E. (ESSA, Boulder, Colo.). J. Geophys. Res.; 75: 4893(1 Sep 1970).

Sitings of stable auroral red arcs (SAR) that were observed in 1967, 1968, and 1969 from Fritz Peak and Richland, Washington are listed. The Richland, Washington observers noted the frequency at a time shortly after a relatively low sunspot maximum and suggested that the indication from Fritz Peak data that SAR arcs occur more frequently near sunspot maximum than at sunspot minimum might be a result of the distance of Fritz Peak from the auroral zone. A 1966 analysis that "SAR arcs tend to occur at sunspot maximum" tends to be correct. It is not suggested that SAR arcs never occur at other times. (J.C.W.)

47119 ARTIFICIAL ENHANCEMENT OF ENERGETIC PARTICLE PRECIPITATION THROUGH COLD PLASMA INJECTION: A TECHNIQUE FOR SEEDING SUBSTORMS? Brice, Neil (Cornell-Sydney Univ. Astronomy Center, Ithaca, N. Y.). J. Geophys. Res.; 75: 4890-2(1 Sep 1970).

Cold plasma injection from the ionosphere into the magnetosphere could produce enhanced whistler-mode turbulence and associated precipitation of energetic electrons (Brice, 1969). It is now pointed out that, in suitable energetic electron distributions, a substantial increase in precipitation can be achieved by injection of very modest amounts of cold plasma. An experiment that would use this effect to measure several parameters in the magnetosphere is proposed. The proposed experiment could provide information on diffusion of plasma along field lines, diffusion across field lines, electric fields deep in the magnetosphere, and magnetic field line shape. The possibility of triggering substorms would provide information about the mechanism of substorm processes and provide predictions for the existence of radar clutter or quality of polar radio-communication circuits. (J.C.W.)

47120 COINCIDENT F-REGION TEMPERATURE DETERMINATIONS FROM INCOHERENT BACKSCATTER AND DOPPLER

BROADENING OF [OI] 6300 A. Cogger, L. L. (Arecibo Observatory, Puerto Rico); Nelson, G. J.; Biondi, M. A.; Hake, R. D. Jr.; Sipler, D. P. J. Geophys. Res.; 75: 4887-9(1 Sep 1970).

The temperature of the nighttime F region was obtained using a Fabry–Perot spectrometer for measuring the Doppler line width of [O I] 6300-A emission and from analysis of data from incoherent scatter radar. Agreement was within ±15% rms. At the altitude of emission the excited $O(^1D)$ atoms produced by dissociative recombination of O_2^+ should attain thermal equilibrium, and measurements of the Doppler broadening of emission arising from the $^3P - {}^1D$ transition reflect the true neutral temperature. There is little or no energy input into the F region at night, so at a given height the ion, electron, and neutral temperatures should be equal. Doppler airglow temperatures can be directly compared with radar backscatter measurements. Coincident observations were made at Arecibo, Puerto Rico. (J.C.W.)

47121 DISCREPANCY IN ELECTRON TEMPERATURES DEDUCED FROM LANGMUIR PROBES AND FROM INCOHERENT SCATTER RADARS. Carlson, H. C. (Arecibo Ionospheric Observatory, Puerto Rico); Sayers, J. J. Geophys. Res.; 75: 4883-6(1 Sep 1970).

A disturbing discrepancy exists between incoherent scatter radar and satellite-borne Langmuir probe measurements of electron temperatures. The discrepancy is not dependent or randomly variable on the incoherent scatter station, satellite, or geophysical conditions. Factors affecting the determinations are cited from previous experiments and conclusions. Data collected on Alouette II, and Explorer 31 and 32 are compared with radar data and the disagreement is not yet solved. It seems desirable to direct effort to examine the possible relevance of work function drift, under ionospheric conditions, while sweeping the probe potential through its critical few tenths of a volt. (J.C.W.)

47122 COMPARISON OF RADAR AND OPTICAL TEMPERATURE MEASUREMENTS IN THE F REGION. Hays, P. B. (Univ. of Michigan, Ann Arbor); Nagy, A. F.; McWatters, K. D.; Evans, J. V. J. Geophys. Res.; 75: 4881-2(1 Sep 1970).

Results of comparative temperature measurements made by the Millstone Hill incoherent scatter radar facility and the Michigan Airglow Observatory during the night of October 14–15, 1969 are given. The incoherent scatter radar measurement technique of ion temperatures and the radar facilities at Millstone Hill have been previously described (Evans, 1969). Ground-based observations of the Doppler broadening of 6300-A atomic oxygen emission line to measure the temperature of the upper atmosphere have been made (Jarrett and Hoey, 1966; Biondi and Fiebelman, 1968; et al.). Comparison of results shows that ion temperature values obtained with the radar backscatter technique and the 6300-A Doppler temperature measurements can be used as a monitor of the exospheric neutral gas temperature. (J.C.W.)

47123 PHOTOELECTRON ESCAPE FLUX OBSERVATIONS AT MIDLATITUDES. Heikkila, W. J. (Univ. of Texas, Dallas). J. Geophys. Res.; 75: 4877-9(1 Sep 1970).

A soft-particle spectrometer was flown on the ISIS-I satellite for auroral particle studies in the energy range 10 eV to 10 keV. It has provided extensive observations of photoelectron fluxes at all latitudes and local times, but the midlatitude observations are discussed in this paper. Results are shown of an apogee pass at 3500 km over Australia on February 9, 1969. It is concluded that the magnetosphere is highly transparent at midlatitudes to the more energetic photoelectrons, and that most of the photoelectron energy is deposited far below 3500 km. (J.C.W.)

47124 UNIVERSAL TIME CONTROL OF THE SOUTH POLAR F LAYER DURING THE IGY. Pike, C. P. (Air Force Cambridge Research Labs., Bedford, Mass.). J. Geophys. Res.; 75: 4871-6 (1 Sep 1970).

A reexamination of south polar F layer data from the International Geophysical Year was made, and these results were compared with recent satellite measurements of low-energy electrons. The ionospheric data were plotted so that they would show more clearly the dominance of universal time in the control of polar F layer electron densities. This plot of the data also establishes the clear dependence of polar F layer electron densities on corrected geomagnetic latitude. Comparison between the latitudinal dependence of the F layer electron densities and that of the low-energy electron measurements shows close agreement. This agreement suggests that influxes of low-energy electrons into the ionosphere may be responsible for maintaining or enhancing the south polar F layer. Thus, if universal time control of the F layer is due to precipitation of low-energy electron fluxes, one could say that electron precipitation itself must be dependent on universal time. The latitudinal dependence of south polar F layer electron densities indicates that in winter the area of universal time control is restricted to corrected geomagnetic latitudes greater than 50°. Other workers have indicated that in summer universal time control existed at midlatitudes, but only in the South American sector. Present satellite measurements do not support an intrusion of these low-energy electrons down to midlatitudes. Thus, an unknown process confined to this area in summer appears to be operating. (auth)

47125 DIFFERENTIAL-PHASE PARTIAL-REFLECTION TECHNIQUE FOR THE DETERMINATION OF D-REGION IONIZATION. von Biel, H. A.; Flood, W. A.; Camnitz, H. G. (Cornell Aernautical Lab., Buffalo). J. Geophys. Res.; 75: 4863-70(1 Sep 1970).

The theory underlying D region partial-reflection experiments is briefly reviewed. Formulas are derived that provide a basis for determination of electron density from analysis of differential phase. Electron density profiles obtained from the application of the differential-absorption and differential-phase techniques are presented and compared. (auth)

47126 ELECTRON PRODUCTION IN THE IONOSPHERIC D REGION BY COSMIC X RAYS. Francey, R. J. (Univ. of Tasmania, Hobart, Australia). J. Geophys. Res.; 75: 4849-62(1 Sep 1970).

The effect of cosmic x rays on ionization rates in the D region is investigated. Information on the major x ray sources is summarized, and electron production rates are calculated for a full range of representative spectra at altitudes between 60 and 110 km. The electron production rate profiles are compared with profiles for galactic cosmic rays and nighttime hydrogen Lyman radiation, including possible variations in the sources, interplanetary space, and atmosphere. Above about 90 and below 80 km, the electron production is dominated by the Lyman radiation and cosmic rays, respectively. Between 80 and 90 km, the diffuse x-ray background makes a stable contribution, which can exceed that due to cosmic rays and Lyman β. During transit the stronger point x-ray sources produce even bigger effects. The large uncertainties in the nitric oxide concentration in the atmosphere make the Lyman α contribution difficult to assess, although it almost certainly dominates the x-ray effect under certain conditions. (auth)

47127 VERTICAL TRANSPORT OF MINOR CONSTITUENTS IN THE LOWER THERMOSPHERE BY NONLINEAR PROCESSES OF GRAVITY WAVES. Hodges, R. R. Jr. (Univ. of Texas, Dallas). J. Geophys. Res.; 75: 4842-8(1 Sep 1970).

Diffusive transport of a minor constituent in the thermosphere is influenced by winds and gradients of density and temperature. Large-amplitude fluctuations of these parameters occur regularly, probably owing to propagation of internal gravity waves. The time average effect of the wave-induced atmospheric fluctuations on diffusion is to transport lighter gases downward and heavier gases upward. Application of this result to helium shows that wave action can account for a noticeable decrease in the density scale height from that of diffusive equilibrium, a common phenomenon of the lower thermosphere. (auth)

47128 F-REGION IRREGULARITIES THAT CAUSE SCINTILLATIONS AND SPREAD-F ECHOES AT LOW LATITUDE. Huang, Chun-ming (National Taiwan Univ., China). J. Geophys. Res.; 75: 4833-41(1 Sep 1970).

The temporal variations of two types of spread-F echoes and scintillation of stationary satellites observed at a low-latitude site are studied. The correlations among the three phenomena and with the Kp index are also investigated. Each type of spread F has quite simple variational characteristics, unlike the admixture of both types. The range spread is maximum at 2100 to 0100 hours during equinoxes and at high sunspot numbers, whereas the frequency spread is maximum at 0300 to 0500 hours during summer and at low sunspot numbers. The correlation with Kp is statistically significant for range spread, but not for frequency spread. The association of scintillation occurrence with range spread is excellent, whereas that with frequency spread is scarcely significant. The existing models of F-region irregularities that may cause the spread-F echoes and scintillations at low latitude are also discussed in the light of the findings. (auth)

47129 DIURNAL VARIATIONS OF THE ATOMIC OXYGEN DENSITY AND TEMPERATURE DETERMINED FROM INCOHERENT SCATTER MEASUREMENTS IN THE IONOSPHERIC F REGION. Bauer, P. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France); Waldteufel, P.; Alcayde, D. J. Geophys. Res.; 75: 4825-32(1 Sep 1970).

Recent studies have shown that exospheric temperatures can be obtained from incoherent scatter experiments. A method proposed by Carru et al. (1967) is extended to yield the atomic oxygen density and a temperature shape parameter. The method involves the determination, by means of a nonlinear regression analysis,

of the values of neutral temperature and oxygen density that best reproduce the measured ion temperature profile, given measured profiles of electron density and electron temperature. By this method, it is possible to obtain a continuous daytime variation of the neutral parameters with a relative accuracy of 15 to 20%. The first results exhibit a definite day-to-night variation of the atomic oxygen density, which is compared to the variation given by the Jacchia and Cira models. (auth)

47130 F-REGION HEATING OBSERVED DURING THE MAIN PHASE OF MAGNETIC STORMS. Evans, J. V. (Lincoln Lab., Lexington, Mass.). J. Geophys. Res.; 75: 4815-23(1 Sep 1970).

The variation of the F-region electron temperature observed at Millstone Hill during geomagnetic storms that occurred in June, August, and September 1965 is discussed. These measurements, made by using the incoherent (Thomson) scatter technique, show the existence of nocturnal heating of the electrons. In the June storm there is also evidence of an anomalously large heat flux ($\sim 10^{10}$ ev/cm^2/sec) from the magnetosphere into the F region during the daytime. All periods of heating appear to occur during the main phase of the storm, as observed at Honolulu, and are usually accompanied by marked decreases in the intensity of the total field observed locally. On the basis of the present observations it is not possible to exclude precipitation of low-energy particles as the heating mechanism, but a more likely explanation seems to be that the heat is generated through the production or decay of the ring current and is conducted along field lines into the ionosphere. As such these observations provide support for the heat conduction theory developed by K. D. Cole (1955) to explain the stable red arc. (auth)

47131 MIDLATITUDE IONOSPHERIC TEMPERATURES DURING THREE MAGNETIC STORMS IN 1965. Evans, J. V. (Lincoln Lab., Lexington, Mass.). J. Geophys. Res.; 75: 4803-13(1 Sep 1970).

Incoherent (Thomson) scatter observations of F-region densities and temperatures were made at Millstone Hill during magnetic storms that occurred in June, August, and September 1965. For the storms of August and September, we have been able to compare the average F region electron and ion temperatures observed in the first 24 hours of the storm with those of the preceding 24 hours. The June measurements, made during the first 48 hours of the storm, have been compared with the average behavior a year earlier and with measurements made on magnetically quiet days in July 1965. In all cases, it is found that there are no changes in electron temperature greater than 30% during the daytime for altitudes below 800 km. Nocturnal increases of electron temperature as large as 100% are sometimes found, but their occurrence is not directly related to the planetary magnetic index Kp. A decrease in $N_{max}F_2$ observed during part of one of the magnetic storms does not appear to have been caused by an increase in the loss coefficient resulting from a dependence on electron temperature. (auth)

47132 PHOTOELECTRON EXCITATION OF N_2 IN THE DAY AIRGLOW. Doering, J. P.; Fastie, William G.; Feldman, P. D. (Johns Hopkins Univ., Baltimore). J. Geophys. Res.; 75: 4787-4802(1 Sep 1970).

The intensity of the 3371 A (0,0) band of the N_2 second positive system and the energy spectrum and flux of daytime photoelectrons were measured simultaneously between the altitudes of 100 and 300 km with instruments aboard a Nike-Tomahawk rocket. A zenith intensity of 230 rayleighs above 120 km was observed, and a maximum volume emission rate of 25 photons sec^{-1} cm^{-3} was found to occur near 155 km. The altitude profile calculated by using the measured electron flux and the known excitation cross section for the $C^3\Pi_u$ state gives an excellent fit to the photometer data. A study of the electron excitation of the first positive bands of N_2 predicts a dayglow intensity of the (1,0) band that is in good agreement with a recent observation. (auth)

47133 OXYGEN ATMOSPHERIC AND INFRARED ATMOSPHERIC BANDS IN THE AURORA. Megill, L. R. (ESSA, Boulder, Colo. Utah State Univ., Logan); Despain, A. M.; Baker, D. J.; Baker, K. D. J. Geophys. Res.; 75: 4775-85(1 Sep 1970).

Two rockets, instrumented to measure auroral optical emissions and many other auroral parameters, were flown from Fort Churchill on March 21 and 30, 1969, into two similar auroras. The intensities of both the atmospheric and the infrared atmospheric bands of O_2 were found to be extremely high, both absolute and relative to the N_2^+ radiation at 3914 A. Although the O_2 emissions were generally spatially correlated with the N_2^+ emissions, consistent differences in volumes of emission were observed, implying that the $O_2(^1\Delta_g)$ must be excited by a different process than the N_2^+. Consequently, many possible excitation mechanisms were studied. It was concluded that much energy is deposited into the auroral atmosphere through mechanisms other than direct excitation by energetic particles. Although there were insufficient data to draw absolute conclusions, a possible mechanism, which appears to be consistent with the experimental results, is electric field heating of ambient electrons and the subsequent excitation of O_2 molecular electronic states. (auth)

47134 AURORAL PROTON OVAL. Rees, M. H.; Benedict, P. C. (Univ. of Colorado, Boulder). J. Geophys. Res.; 75: 4763-74(1 Sep 1970).

The auroral spectrum was recorded at Byrd Station, Antarctica, during the austral winter of 1967. Hydrogen Balmer line radiation was detected throughout the 24-hour day, depending on magnetic activity. The radiation defines an oval of proton precipitation that, as viewed from the particular location, appears as an equatorward movement around noon (eccentric dipole time) and as a poleward recession after midnight. The position and extent of the oval appear to depend on the degree of magnetic activity. Based on the latitude interval accessible to observation (65 to 73°S geomagnetic latitude), the proton precipitation oval is displaced with respect to the Akasofu-Feldstein (electron) oval, and thus it is equatorward in the afternoon sector and overlaps the electron oval during the forenoon period. (auth)

47135 CHARACTERISTICS OF TRANSVERSE MAGNETIC DISTURBANCES OBSERVED AT 1100 KILOMETERS IN THE AURORAL OVAL. Zmuda, A. J. (Johns Hopkins Univ., Silver Spring, Md.); Armstrong, J. C.; Heuring, F. T. J. Geophys. Res.; 75: 4757-62(1 Sep 1970).

Transverse magnetic disturbances are almost always present. Under magnetically quiet conditions, the disturbance region has a diurnal variation and lies between 77 and 80° invariant latitude at noon and between 69 and 72° at midnight. With increasing magnetic activity, the disturbance region moves equatorward and widens, mainly through the displacement of the lower boundary. The intensity varies from about 30 γ, the minimum detectable, to about 900 γ. The disturbances are compatible with effects due to field-aligned currents that, from rough estimates, contain particle fluxes in the range 0.12 to 3.5×10^9 particles/cm^2 sec, depending on the field magnitude. (auth)

47136 AURORAL ARCS: RESULT OF THE INTERACTION OF A DYNAMIC MAGNETOSPHERE WITH THE IONOSPHERE. Atkinson, G. (California Inst. of Tech., Pasadena). J. Geophys. Res.; 75: 4746-55(1 Sep 1970).

A model of auroral arcs is presented. It is assumed that the magnetic field lines into the auroral oval are loaded with keV electrons, that precipitating auroral electrons locally constitute a net field-aligned current, and that currents close in the outer magnetosphere by polarization currents. The model predicts that a flux tube convecting through the oval will undergo a highly nonlinear oscillation that produces standing waves, the auroral arcs. The conditions to be satisfied are (1) Ohm's law in the ionosphere, (2) electron number conservation in the ionosphere, (3) electric current continuity, (4) the tendency for electric fields to map between ionosphere and magnetosphere. The physics of condition 4 is not understood, but it is probable that arc-like solutions exist for several models. A specific model, including perfect mapping of electric fields, is studied. The solutions to this model closely resemble the arcs. Predicted in agreement with observation are arc thickness, inter-arc spacing, and the electric field behavior. The thickness and the spacing are functions of both the amplitude of the oscillation and the physical properties of the system. However, thickness times spacing is a function of the physical properties only, and the thickness divided by the spacing is a function of amplitude only. Presumably these and other quantitative relationships can be checked by observations. (auth)

47137 SOME STATISTICS ON Pc 1 GEOMAGNETIC MICROPULSATION OCCURRENCE AT MIDDLE LATITUDES: INVERSE RELATION WITH SUNSPOT CYCLE AND SEMI-ANNUAL PERIOD. Fraser-Smith, A. C. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 4735-45(1 Sep 1970).

The monthly rate of occurrence at California stations of hydromagnetic (hm) emissions, which are the predominant micropulsations in the Pc 1 category, was analyzed for the 12-year interval January 1955 through December 1966. The over-all approximate inverse relation between the hm emission occurrence rates and the sunspot cycle, first suggested by H. Benioff (1960), was confirmed. However, there were some significant departures from the strict inverse relation during the interval of the observations. In particular, there was a secondary peak of hm emission activity during 1960, when the rate of decrease of sunspot numbers was at its maximum, and there was some evidence for smaller peaks

when the rate of increase of sunspot numbers was also a maximum. Furthermore, the cycle of hm emission occurrences appeared to precede the sunspot cycle by close to a year. There was some similarity in structure between the hm emission cycle and the smoothed variation of the Ap geomagnetic index over the same interval, even though the over-all Ap cycle varied with, or a little behind, the sunspot cycle and therefore differed considerably, on this basis, from the hm emission cycle. The California cycle of hm emission occurrences and the cycle observed at stations in the USSR are compared. There are a number of differences between the two cycles, the most striking of which is the absence of a maximum in the USSR data close to the sunspot minimum of 1964. The hm emission occurrences in California over the 12-year interval had a semiannual period, with a marked peak of activity during April and a smaller peak during September and October. There were minima of activity during January and June. The annual variation is similar to that shown by the Ci and Ap geomagnetic indices. (auth)

47138 ARTIFICIAL INJECTION OF ELECTRONS INTO THE GEOMAGNETIC FIELD BY TEAK AND ORANGE, LOW-ALTITUDE BURSTS OF 1958. Manson, D. J.; Fennell, J. F.; Hoverter, R. T.; Hickerson, J. L.; George, J. A.; Maldonado, G. V.; Weber, A. H. (St. Louis Univ.). J. Geophys. Res.; 75: 4710-19(1 Sep 1970).

Recent analysis of Explorer 4 data establishes that a shell of trapped electrons at L = 1.2 approximately 115 km wide at the half-maximum intensity points resulted from the Teak burst 77 km above Johnston Island, August 1, 1958. Maximum unidirectional flux ($E_e > 0.58$ MeV) above background was 1.4×10^5 electrons cm^{-2} $ster^{-1}$ sec^{-1}. The shell was observed for about three days from the Johannesburg, Lima, Singapore, and Johnston Island tracking stations. Buildup at the L = 1.2 shell was not immediate, reaching a maximum about 24 hours after the event. Initial observations (Singapore 18 min and Johnston Island 7 hours after the burst) showed maximum trapping at L = 1.14. It is estimated that between 10^{19} and 10^{20} electrons were trapped one hour after the burst. Artificial injection from Orange (43 km) was found to be located principally above Johnston Island and was of short term (less than 1 day) and small magnitude. (auth)

47139 TURBULENT LOSS OF RING-CURRENT PROTONS. Cornwall, John M.; Coroniti, F. V.; Thorne, R. M. (Univ. of California, Los Angeles). J. Geophys. Res.; 75: 4699-4709 (1 Sep 1970).

Ring-current protons (<50 keV), which are unaffected by ion cyclotron waves outside the plasmapause, undergo strong turbulent diffusion just inside the plasmapause. Lifetimes from ion cyclotron turbulence are predicted to be of the order of 1 hour, as observed by Frank for $3 \leq L \leq 5$. During the main phase of a geomagnetic storm, the protons rapidly diffuse across the plasmapause (probably at the Bohm rate) and are lost before reaching the noon meridian, thus giving rise to the asymmetric part of the ring current. During recovery phase the ring current decays on a time scale of a day or less, as the turbulent region moves outward with the expansion of the plasmapause. Further decay takes place on a charge-exchange time scale. (auth)

47140 EFFECTS OF IONOSPHERIC CONDUCTIVITY ON CONVECTIVE FLOW OF PLASMA IN THE MAGNETOSPHERE. Wolf, R. A. (Rice Univ., Houston, Tex.). J. Geophys. Res.; 75: 4677-98(1 Sep 1970).

Convecuve flow of plasma in the magnetosphere is apparently driven by the interaction between the solar wind and the magnetosphere, but the flow pattern is regulated by the ionosphere and by pressure gradients in the magnetospheric plasma. The equations for conservation of ionospheric currents are used here to deduce theoretical flow patterns. The currents caused by the pressure of magnetospheric plasma are neglected. When all merging and friction processes are assumed to take place in the tail, and the dayside magnetopause is assumed to be an equipotential, computed trajectories of plasmasphere particles generally exhibit bulges in the dusk-to-midnight sector; if the conductivity model includes a sharp drop in conductivity at sunset, the computed bulge has a sharp onset near local sunset. When convection is assumed to be caused by merging or some other friction process operating near the nose of the magnetosphere, the outer-plasmasphere trajectories have pronounced bulges in the dusk-to-midnight sector, with sharp onset near local sunset, if the conductivity model includes a sharp drop in conductivity at local sunset and a band of substantially enhanced Pedersen and Hall conductivities in the auroral zone. Vasyliunas' observations indicate that the plasma sheet is generally well defined throughout the evening and afternoon sectors of the magnetosphere, to about 1300 LT. Comparing the observed plasma-sheet region with the regions of the computed flow patterns that are accessible to kilovolt electrons from the tail, we find agreement only in cases where the day-night asymmetry is included in the conductivity model, and only when a potential drop $\gtrsim 35$ kV is assumed to exist across the nose region of the magnetosphere. Throughout most of the afternoon and evening sectors, the computed shape of the inner edge of the plasma sheet is insensitive to the assumption about the rate of precipitation. The computed ionospheric current patterns resemble observed currents only if the auroral-zone Pedersen and Hall conductivities are assumed to be enhanced by an order of magnitude or more over the midlatitude nightside conductivities. When peak auroral-zone enhancements of the Pedersen and Hall conductivities are taken to be 3.3 and 10 mhos, respectively, current patterns computed assuming a large voltage drop across the nose of the magnetosphere are roughly consistent with observed DP2 fluctuations; currents computed assuming that all merging activity takes place in the tail then generally resemble DS currents. (auth)

47141 LARGE-AMPLITUDE HYDROMAGNETIC WAVES IN THE INNER MAGNETOSHEATH. Kaufmann, Richard L.; Horng, Jiann-Tsorng; Wolfe, Allan (Univ. of New Hampshire, Durham). J. Geophys. Res.; 75: 4666-76(1 Sep 1970).

It is found that slow magneto-acoustic waves produce the magnetic field perturbations of the largest amplitude in the 0.01- to 0.1-Hz frequency range within the highly disturbed magnetosheath. The frequencies quoted are frequencies seen by the satellite. Rotational Alfvén waves with periods of several minutes and longer are also detected on most orbits. The power spectrum of rotational waves usually rises much more steeply below 0.01 Hz than the power spectrum of magneto-acoustic waves. It is concluded that the magneto-acoustic waves are produced or strongly amplified at the Earth's bow shock or in the outer magnetosheath. The observed rotational waves may be produced beyond the bow shock or in the outer magnetosheath. The observed rotational waves may be produced beyond the bow shock and carried into the magnetosheath by the solar wind. (auth)

47142 SOLAR-WIND PROTON PROPERTIES: VELA 3 OBSERVATIONS FROM JULY 1965 TO JUNE 1967. Hundhausen, A. J.; Bame, S. J.; Asbridge, J. R.; Sydoriak, S. J. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 75: 4643-57(1 Sep 1970).

Observations of the solar wind proton component made between July 1965 and June 1967 on the twin Vela 3 satellites are analyzed to give a statistical description of solar wind properties. Distributions of the observed proton density, flow speed, flow direction, thermal anisotropy magnitude, and anisotropy orientation are displayed; average values, standard deviations from the averages, median values, and ranges are given for this set of measured properties. Relationships among the solar wind properties are discussed. The distributions of the logarithm of the proton temperature, at differing flow speeds, are nearly normal, with a constant standard deviation from an average that increases with increasing flow speed. Statistical description of several basic plasma parameters and the measured solar wind properties under quiet conditions are also presented. (auth)

47143 LARGE-SCALE CHARACTERISTICS OF FLARE-ASSOCIATED SOLAR-WIND DISTURBANCES. Hundhausen, A. J.; Bame, S. J.; Montgomery, M. D. (Los Alamos Scientific Lab., N. Mex.). J. Geophys. Res.; 75: 4631-42(1 Sep 1970).

The large-scale properties of 19 flare-associated solar wind disturbances observed by Vela 3 and Vela 4 satellites between August 1965 and June 1967 were examined. It was generally found that the solar wind flow speed rises above the value measured immediately after the shock at the leading edge of such disturbances and remains elevated for at least 1 day. The mass and energy fluxes may either rise or fall after the discontinuous change at the shock. Integration of the excess of these fluxes above the preshock or ambient level gives the total mass and energy in the interplanetary disturbance. The average mass is found to be 3×10^{16} g; the average energy (at 1 AU) is 5×10^{31} ergs. Both the mass and energy are smaller for disturbances in which the energy flux falls after the shock than for disturbances in which it rises. Both quantities are larger for disturbances observed in early 1967 than for those observed in late 1965, thus suggesting that the mass and energy deposited in the solar wind by individual flares increased with the rise in solar activity during the period under discussion. The energy released by the flare (obtained by correcting for the solar gravitational potential at 1 solar radius) is found to be proportional to the mass released, despite variation of more than an order of magnitude in both quantities. (auth)

47144 SHAPE OF A SOLAR WIND DISTURBANCE ON JULY 9, 1966, INFERRED FROM RADIO SIGNAL DELAY TO PIONEER 6. Landt, Jeremy A.; Croft, Thomas A. (Stanford Univ., Calif.). J. Geophys. Res.; 75: 4623-30(1 Sep 1970).

Two days after the widely studied solar flare of July 7, 1966, an attempt was made to measure the average free-electron number density of the solar wind between Earth and Pioneer 6, by running the dual frequency experiment beyond its design range. A recent detailed re-examination of the raw data revealed that a worthwhile measurement could be inferred from part of the apparatus response; however, this measurement is ambiguous because of an inability to count the full cycles of the modulation phase of the radio signals. Three average-density versus time curves were drawn from the same data. The average number density along the Earth-Pioneer line was compared with local number density measured at each end of the line. During these measurements, a large plasma cloud, preceded by a shock, engulfed the Pioneer and passed beyond. Timing and orientation were consistent with the theory that the cloud was ejected by the July 7 flare. Plasma-cloud models were constructed in accordance with these data, following guidelines established by others who have attempted to determine the probable shape of shocks attributable to some solar flares. From these comparative studies, the most credible of three possible measurements was selected subjectively. (auth)

47145 PENETRATION OF LOW-ENERGY SOLAR PROTONS TO LOW GEOMAGNETIC LATITUDES. Bewick, A.; Haskell, G. P.; Hynds, R. J. (Imperial Coll. of Science and Tech., London). J. Geophys. Res.; 75: 4605-12(1 Sep 1970).

Changes in the geomagnetic cutoff latitude for low-energy (>2 MeV) solar protons are compared with changes in the high-latitude boundary of trapped energetic electrons during a magnetically disturbed period. These changes were measured with good time resolution. The observations suggest that the depression of the cutoff latitude is partly due to an enlargement of the region of direct access, as indicated by the depression of the trapped electron boundary. In addition, solar protons become trapped and are transported to lower latitudes during magnetospheric substorms. (auth)

47146 NEUTRON FLUX AT BALLOON ALTITUDES DURING A SOLAR PROTON EVENT. Greenhill, J. G. (Univ. of Tasmania, Hobart, Australia); Fenton, K. B.; Fenton, A. G.; White, K. S. J. Geophys. Res.; 75: 4595-4603(1 Sep 1970).

A large increase in the atmospheric neutron flux was observed at balloon altitudes on September 3, 1966, during a solar proton event. The flux and energy spectrum of the solar particles are known with some precision from satellite detectors, as well as from our balloon measurements. From these data quantitative comparisons have been made with the predictions of Lingenfelter and Flamm (1964) on the production of neutrons in the atmosphere by proton interactions. The theory is in satisfactory agreement with the observations, although there is considerable uncertainty about the fraction of neutrons that leaked out of the atmosphere. (auth)

47147 RAPID VARIATIONS OF IONIZATION IN TWO MAGNETIC CONJUGATE REGIONS OF THE F2 LAYER. Benkova, N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio Wave Propagation, Moscow); Boukin, G.; Kolokolov, L.; Faynot, J.; Lafeuille, M.; Taieb, C. Ann. Geophys.; 25: 605-8(1969). (In French).

An ionospheric sounder transported by a plane operated over the conjugate area of Kerguelen (TAAF) surrounding Sogra (USSR). Correlation coefficients of foF2 variations at the two conjugate areas were calculated as function of space and time. It is shown that the variations are different for quiet days and disturbed days. (tr-auth)

47148 DIFFERENT ASPECTS OF THE DIURNAL VARIATION OF THE TOTAL ELECTRON CONTENT OF THE IONOSPHERE AT MIDDLE LATITUDES. Bertin, F.; Papet-Lepine, J. (Laboratoire de Physique de l'Atmosphere, Paris). Ann. Geophys.; 25: 589-604(1969). (In French).

With respect to the solar cycle, the variation of the total electron content (T.E.C.) at noon is not the same for the different seasons. Three parabolic relations are found, corresponding respectively to the winter, summer, and equinoxes. Only two relations are found (one for summer and another for the equinoxes) when all diurnal maxima are considered, whatever be their time of occurrence. A semiannual variation can be seen on the midday total electron content, the amplitude of which decreases when solar activity increases. There is a good correlation between this semiannual T.E.C. variation and the equivalent slab-thickness variation. By studying the diurnal and seasonal variations of slab thickness and T.E.C. measurements, it is possible to deduce some ionospheric properties in function of the main geophysical parameters. It is not always possible to explain these different ionospheric properties in terms of recombinations governed by the local electron temperature. It seems that the transport phenomena are more likely to give a valid explanation. (tr-auth)

Low-Temperature Physics

Refer also to abstracts 46719, 46755, 46780, 46789, and 47059.

47149 (CEA-N-1366) APPARATUS FOR THE MEASUREMENT AND THE REGULATION OF LOW TEMPERATURES. Barraud, Andre; Gras, Roger (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 25 May 1970. 27p. (In French). Dep. CFSTI (U. S. Sales Only).

An apparatus is described for the measurement and stabilization of the temperature of small enclosures, a particular application being that of a variable temperature liquid helium cryostat. This apparatus allows the use of various temperature regulators. Using a graphite resistance regulator this apparatus permits temperature stabilization between 2°K and 150°K. At 6°K the stability is 10^{-3}°K. Some special features are: the low electric dissipation across the regulator, the large gain of the error amplifier, and the inverse parabolic characteristics of the final stage allowing the maximum use of loop gain. (France)

47150 (IS-T-405) SUPERCONDUCTIVITY AND MAGNETIC ORDER IN La-Ce ALLOYS. Wollan, John Jerome (Ames Lab., Iowa). Sep 1970. Contract W-7405-eng-82. 96p. Dep. CFSTI. Thesis.

Superconductivity and magnetic order have been studied both above and below the Kondo temperature for the La-Ce system. Electrical resistivity measurements on La 0.2, 1.0, 2.0, 3.2, and 4.0 wt. % Ce have been made from 0.06 K to 20 K. All samples showed a Kondo-like minimum, T_{min}, in the resistivity with a subsequent maximum, T_{max}. T_{min} was found to be proportional to $n^{1/2}$, where n is the concentration, and $T_{max}(H = 0)$ was proportional to n^2. The slope of the resistivity due to the magnetic impurities went as $\rho_2 \ln T$ on both sides of T_{max}. Above T_{max} the proportionality constant, ρ_2, was almost independent of n, and below T_{max} it was proportional to n^2. Applied magnetic fields had little effect on ρ_2 even though T_{max} increased linearly with H. The magnitude of the resistivity at the peak was essentially independent of n but decreased for increased H. The superconducting transition temperature was depressed as n increased, but more slowly than predicted by Abrikosov and Gor'kov, and the critical field curves were considerably depressed below the multiple pair breaking theory of Fulde and Maki. (auth)

47151 COEXISTENCE OF SUPERCONDUCTIVITY AND SHORT-RANGE MAGNETIC ORDER. Williams, L. J.; Decker, W. R.; Finnemore, D. K. (Iowa State Univ., Ames.). Phys. Rev., B; 2: 1287-93(1 Sep 1970).

Thermal conductivity measurements on the La-Lu-Tb alloy system show that short-range magnetic order in the magnetic-impurity spin system does not change the superconducting properties in a substantial way. There appears to be no anomaly in the thermal conductivity at the temperature where short-range order occurs. The critical-field curves are depressed far below the prediction of the multiple-pair-breaking theories, and this seems to indicate the presence of a strong exchange-field enhancement. (auth)

47152 TRANSITION TEMPERATURE OF SUPERCONDUCTING INDIUM, THALLIUM, AND LEAD GRAINS. Watson, J. H. P. (Corning Glass Works, N. Y.). Phys. Rev., B; 2: 1282-6(1Sep 1970).

Experimental results on the transition temperature of indium, thallium, and lead grains of various sizes, together with preliminary measurements on other metals, can be interpreted in terms of changes in the phonon spectrum that alter the electron-phonon coupling constant, although some anomalies exist. (auth)

47153 DEPENDENCE OF THE HIGH-FIELD FLUX-FLOW RESISTIVITY UPON THE SAMPLE DEMAGNETIZATION FACTOR IN TYPE-II SUPERCONDUCTORS. Kuhl, G. E.; Ohmer, M. C. (Air Force Materials Lab., Wright-Patterson Air Force Base, Ohio). Phys. Rev., B; 2: 1264-70(1 Sep 1970).

The orientational dependence of the flux-flow resistivity ρ_f due to the sample geometry was determined experimentally in several type-II Pb-Tl alloys at 4.2°K. The demagnetization factors of the samples were varied from 0.1 to 0.9 by rotating the magnetic field in relation to the sample plane, always perpendicular to the sample current. The flux-flow resistivity increased with decreasing demagnetization factor for $Pb_{0.971}Tl_{0.029}$ and $Pb_{0.95}Tl_{0.05}$ samples with κ values of 0.97 and 1.28, respectively. The flux-flow resistivity for a $Pb_{0.95}Tl_{0.49}$ sample with a κ of 4.90 was essentially independent of the demagnetization factor. The experimental results were found to agree with the theoretical demagnetization-factor dependence of ρ_f predicted by Caroli and Maki and by Cape and Zimmerman. (auth)

47154 CABLES AT VERY LOW TEMPERATURE FOR THE TRANSMISSION OF ELECTRICAL ENERGY. Von Kafka, W. Elektrotech. Z.; 20B: 273-7(17 May 1968). (In German).

A short description is given of the proposals made so far for very-low-temperature cables, with ordinary conductors at 20°K and with superconductors at 4.2°K, for the transmission of large amounts of electric power using alternating and direct current, and a comparison is made of their technical properties and economic efficiency. The conclusion is drawn that superconductors for alternating and direct current are to be preferred to normal conductors at 20°K. Alternating current cables with coaxial pairs of conductors, and direct-current cables, appear to compare favorably with conventional methods of power transmission for large transmission capacities of several thousand megawatts. Multiconductor superconducting alternating current cables can be used in a power system for reducing short circuit power. (Copper Abstr.) (Sci. Abstr.)

47155 CONTINUOUS COOLING BETWEEN 1 AND 293°K. Klipping, G. Elektrotech. Z.; 89A: 308-10(21 Jun 1968). (In German).

Methods of cooling are described, which by using liquid helium from storage vessels make it possible to achieve any desired temperatures between 1 and 293°K in continuous operation. In the case of bath cryostats the liquid helium is topped up via a sheathed vacuum syphon with a pressure-release valve and a sintered body at the syphon outlet. At temperatures below the λ point, superfluid helium is added through a superfilter. The system of vaporization cryostats is explained on the basis of an arrangement for the cooling of superconducting coils, both in liquid and in supercritical helium. Further, characteristic figures for the heat transfer to supercritical helium are given. (Copper Abstr.) (Sci. Abstr.)

47156 COLLECTIVE EXCITATION SPECTROSCOPY IN SUPERCONDUCTOR–SEMICONDUCTOR TUNNEL JUNCTIONS. Duke, C. B.; Kleiman, G. G. (Univ. of Illinois, Urbana). Phys. Rev., B; 2: 1270-82(1 Sep 1970).

The transfer-Hamiltonian description of the influence of electron–boson interactions on the electrical characteristics of metal-semiconductor tunnel junctions is extended by considering the combined effects of electrode self-energy phenomena and boson-assisted tunneling. The current associated with these processes is evaluated for superconducting metal electrodes described by the pairing model as well as for normal metal electrodes. Numerical evaluations of the conductance are made using models and parameters appropriate for the description of the influence of electron (hole) interactions with optical phonons (energy $\approx \hbar\omega_0$) on the tunneling characteristics of metal contacts on boron-doped silicon. (auth)

47157 EVAPORATION OF ^{3}He ATOMS FROM LIQUID ^{3}He–^{4}He MIXTURES. Widom, Allan (Northeastern Univ., Boston); Hyman, David S. Phys. Rev., A; 2: 818-20(Sep 1970).

A single-particle-propagator (i.e., Green's function) theory of evaporation from quantum liquids is developed and applied to the energy distribution of ^{3}He atoms evaporating from ^{3}He–^{4}He mixtures. The resulting theoretical energy distribution contains no unknown parameters. A distribution described in terms of an effective temperature is predicted which is somewhat higher than the temperature of the liquid. However, the effect is not so pronounced as the temperature shift observed by King and Johnston in the pure-^{4}He evaporation experiment. It is suggested that experiments of this type might be used to measure the Bose condensate fraction of superfluid ^{4}He. (auth)

47158 THERMODYNAMICS OF THE TWO-BAND SUPERCONDUCTORS IN THE PRESENCE OF NONMAGNETIC IMPURITIES. Tang, I-ming (Reed Coll., Portland, Oreg.). Phys. Rev., B; 2: 1299-1305(1 Sep 1970).

The thermodynamics of the two-band model for the superconducting states of transition metals containing nonmagnetic impurities are developed using the Green's-function technique. The thermodynamic functions of the system are expressed in terms of the densities of state of the s and d electrons. Changes caused by the presence of the impurities of the various functions are obtained. It is shown that in the intraband limit $g_{sd} = 0$, the specific heat of transition metals in the superconducting phase is decreased because of the presence of the nonmagnetic impurities. (auth)

47159 EQUILIBRIUM THEORY OF LIQUID HELIUM-FOUR AT ABSOLUTE ZERO. Sposito, Garrison (Sonoma State Coll., Rohnert Park, Calif.). Phys. Rev., A; 2: 948-61(Sep 1970).

A microscopic theory of liquid ^{4}He at absolute zero is developed. The method of attack is a free adaptation of the Bohm–Pines technique for describing the degenerate electron gas, and is an improvement in several ways on the collective treatment of liquid helium carried through by Bohm and Salt using the same technique. In consequence of the approach, it is possible to treat the collective motions accurately and to give a microscopic derivation of the Feynman theory of liquid helium. It is also shown precisely how the latter is related to quantum hydrodynamics and how the Feynman–Cohen state vector for the excited states is the natural and rigorous outcome of relaxing a little the condition that density fluctuations in the liquid do not affect its kinetic energy. The ground-state wave function is computed and shown to be, to a very good approximation, of the same form as that postulated by Chester and his collaborators. This implies strongly that Bose condensation exists in liquid helium and that it is closely related to short-range correlations in the system. Lastly, the microscopic Hamiltonian operator is separated into independent collective and single-particle parts and it is verified that the coupling between the phonon modes and the short-range correlations can induce a velocity-dependent interaction between helium atoms. This new interaction is under certain conditions an attractive one and may play a role in determining the anomalous thermal properties of the liquid. (auth)

47160 MICROSCOPIC THEORY OF QUANTUM FLUIDS. III. QUASIPARTICLE ENSEMBLE FOR DEGENERATE BOSE FLUID. Mohling, F. (Univ. of Colorado, Boulder); Rama Rao, I.; Shea, Dion W. J. Phys. Rev., A; 2: 1002-18(Sep 1970).

The analysis of the preceding two papers in this series is applied to the specific case of a degenerate Bose fluid, in which there can be macroscopic occupation of the zero-momentum state (in a system at rest). The quasi-particle ensemble of Mohling and Tuttle is incorporated into the theory in order to guarantee that Nernst's theorem for the entropy is satisfied. It is shown that a double quasi-particle model emerges naturally from the theory, as developed earlier, and this feature is then incorporated into the quasi-particle ensemble. The general theory is prepared, with the aid of the Λ transformation, for calculational applications. A phenomenological theory of the degenerate Bose fluid, based on the double quasi-particle model, is presented, but no significant physical implications are deduced from it. (auth)

47161 STUDY OF THE MAGNETIC INDUCTION OBSERVATION ASSOCIATED WITH THE FLUX TRANSPORT IN SUPERCONDUCTING BANDS. Minet, R. (Centre National d'Etudes des Telecommunications, Lannion, France). Rev. Phys. Appl.; 5: 291-9(Apr 1970). (In French).

A perturbation of the magnetic induction or a flux spot was generated at a point in a superconducting band, and the flux motion due to a transport current was revealed by a pulse technique. The inductive measurements of the time of flight between two points gave the drift velocities or diffusion constants of the flux; this type of measurements could provide new data related to the flux motion problem in superconductors in normal fields and contribute to a better understanding of their apparent resistivity. (tr-auth) (France)

47162 SUPERCONDUCTING TRANSITION TEMPERATURES OF Nb_3Sn STRIP SAMPLES AFTER SHORT TIME HEAT TREATMENTS. Rassmann, G.; Mueller, P.; Hufnagel, G. (Zentralinstitut fuer Festkoerperphysik und Werkstofforschung, Dresden). Phys. Status Solidi (a); 2: K105-7(16 Jun 1970).

Nb strips were drawn through a Sn bath at 1000°C to form a Nb_3Sn layer. Transition temperatures T_c were measured after heat treatments. A T_c of 18°K could be reached either by a long treatment (60 min or longer) at 1000°C or by a 5-min treatment at 1350°C followed by cooling to 1000°C within 5 min. It is suggested that the latter treatment forms the β-W phase rapidly at 1350°C and orders it at 1000°C. (D.L.C.)

47163 SUPERCONDUCTING CHARACTERISTICS OF ZIRCONIUM–VANADIUM ALLOYS. Pollock, J. T. A.; Shull, R.; Gatos, H. C. (Massachusetts Inst. of Tech., Cambridge). Phys. Status Solidi (a); 2: 251-6(16 Jun 1970).

The critical temperatures, T_c, and critical current density, J_c, were measured for Zr–V alloys containing 6 and 9 at. % V at various stages of aging at 500°C. The microstructure of the samples was determined by metallographic and x-ray-diffraction techniques in conjunction with previously reported studies. The alloys were found to contain mixtures of martensite α′, complex (hcp) ω, and retained (bcc) β phases. Aging resulted in the transformation of these phases to the equilibrium phases, (hcp) Zr-rich α, and the superconducting (at 4.2°K) intermetallic compound V_2Zr. The T_c and J_c results are interpreted in terms of the flux pinning capabilities of the resulting microstructures. (auth)

47164 ENERGY GAPS AND TRANSITION TEMPERATURES OF THE STRONG-COUPLING SUPERCONDUCTORS, LEAD AND

MERCURY, AS FUNCTIONS OF THE MEAN FREE PATHS OF THE ELECTRONS. Ziemba, G.; Bergmann, G. (Univ., Goettingen, Ger.). Z. Phys.; 237: 410-18(1970).

The energy gaps and the transition temperatures of the strong-coupling superconductors lead and mercury are measured as functions of the mean free paths of the electrons. The energy gap of lead increases with decreasing mean free path; the transition temperature is found to be constant. The energy gap of mercury runs through a maximum value with decreasing mean free path whereas the transition temperature decreases. The energy gap of pure mercury is extrapolated to the value 1.58 MeV and yields the ratio $2\Delta_0/kT_c = 4.4$. The experimental results confirm the theoretical prediction that the attractive electron–electron interaction in disordered superconductors is increased. But in addition, the strong-coupling effect appears to become more important in disordered superconductors. A comparison with similar experiments for weak-coupling superconductors is made. (auth)

47165 THEORY OF MAGNETIC IMPURITIES IN SUPERCONDUCTORS. III. STRUCTURE OF THE BOUND STATES. Zittartz, J. (Univ., Cologne). Z. Phys.; 237: 419-26(1970).

The structure of the bound states in superconductors with magnetic impurities is investigated in detail following earlier work. It is shown that there is exactly one bound state per magnetic impurity with a wave function which decays exponentially on a characteristic scale. However, there is no accumulation of charge around the impurity as the bound state charge distribution is compensated by the contribution from band states apart from Ruderman–Kittel oscillations. (auth)

47166 SURFACE EFFECTS AND LOW FREQUENCY LOSSES IN HARD SUPERCONDUCTORS. Sekula, S. T.; Barrett, J. H. (Oak Ridge National Lab., Tenn.). Appl. Phys. Lett.; 17: 204-5(1 Sep 1970).

The power dissipation in a hard superconductor based on a model consisting of a bulk flux pinning region and a surface sheath is calculated. The results indicate that the losses are somewhat greater than previously calculated. (auth)

47167 DIRECT OBSERVATION OF SINGLE MAGNETIC FLUX QUANTUM IN SUPERCONDUCTING TUBES. I. Boersch, H.; Lischke, B. (Technische Univ., Berlin). Z. Phys.; 237: 449-68 (1970). (In German).

By use of electron interferometry in connection with the Aharonov–Bohm effect it was possible to observe directly single magnetic flux quanta, trapped in superconducting tubes with an inner diameter ranging from 0.5 μm to 1 μm. The flux coincided with the fluxoid quantum hc/2e within the experimental error of 4% for thick walled cylinders. The flux distribution along the cylinders was found to be not constant in time and space. Flux quanta down to 8 μm length have been observed. The method permits the observation of flux creep of single flux quanta. (auth)

47168 DETERMINATION OF THE FLUXOID QUANTUM IN SUPERCONDUCTING TUBES. II. Lischke, B. (Technische Univ., Berlin). Z. Phys.; 237: 469-74(1970). (In German).

Electron interferometric measurements on superconducting hollow cylinders with an inner diameter of about 0.7 μm yielded the fluxoid quantum to $\Phi_{0,exp} = 2.1 \cdot 10^{-7}$ Gcm^2 (theoretical value: $\Phi_0 = 2.07 \cdot 10^{-7}$ Gcm^2). For this determination a relation between the experimental values and the fluxoid quantum was derived from the thermodynamic potential. (auth)

47169 SUPERCONDUCTIVITY IN THE $Nb_3(Al,Ge)$ COMPOUND SYSTEM. Ruzicka, Jiri (Univ., Karlsruhe, Ger.). Z. Phys.; 237: 432-41(1970).

Superconducting samples of the nominal composition $Nb_3(Al_{1-y}, Ge_y)_{1-x}$ with x reaching from 0.72 to 0.78 and y from 0.175 to 0.30 were prepared and the superconducting transitions of as-cast and of annealed samples were measured. The onset of superconductivity for samples with a suitable composition and annealing procedure has been observed to be at about 21.05 K. By the help of anodic oxydation process and by multichannel semiconductor x-ray spectroscopy with scanning electron microscope it has been possible to carry out the phases distribution and detailed phase-analysis in the samples. (auth)

47170 CURRENT–PHASE RELATIONS IN SUPERCONDUCTING BRIDGES. Fulton, T. A.; Dynes, R. C. (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett.; 25: 794-7(21 Sep 1970).

The current–phase relation $I_s(\varphi)$ for an Anderson–Dayem bridge is investigated making experimental use of the quantum interference between two such bridges. Neat T_c and for critical currents $\lesssim 10$ μA, $I_s(\varphi)$ is found to be nearly simusoidal. (auth)

47171 ELECTROMAGNETIC PROPERTIES OF SUPERCONDUCTING THIN FILMS WITH PARAMAGNETIC IMPURITIES. Kolpazhiu, M. K. (Inst. of Applied Physics, Kishinev). Sov. Phys.-Solid State (Engl. Transl.); 12: 638-40(Sep 1970).

Translated from Fiz. Tverd. Tela; 12: 825-9(Mar 1970).

The behavior of thin superconducting films in an electromagnetic field is studied for the limit of a high concentration of paramagnetic impurities. Absorption in the gapless region at absolute zero and at low temperature is also treated. The magnetic field penetration depth in the presence of a constant current in the superconductor turns out to be greater than in the zero-current case both at absolute zero and at temperatues close to the critical temperature. (auth)

47172 SUPERCONDUCTIVITY IN TRANSITION METALS WITH NONMAGNETIC IMPURITIES. Kusakabe, Takashi (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 907-16(Apr 1970).

The two-band model proposed by Suhl, Matthias and Walker for the theory of superconductivity of pure transition metals is extended to the transition metals in the presence of nonmagnetic impurities. It is found that the theory of superconductivity in the two-band model is rather sensitive to the choice of the cutoffs of the pairing interactions, in contrast to the expectations in the one-band model. That is, if $\omega_{ss} = \omega_{dd} = \omega_{sd} \equiv \omega_D$, T_c always decreases with increasing impurity concentration and has a complete isotope effect. Furthermore if $\omega_{ss} = \omega_{dd} \neq \omega_{sd}$ ($\omega_{ss} = \omega_D$), T_c always decreases or increases with the impurity concentration according to the case of $|\alpha| < 1$ or $\alpha > 1$, respectively, and does not necessarily have the complete isotope effect, where ω_{ss}, ω_{dd} and ω_{sd} are the cutoffs for interactions giving a pairing of s–s, d–d and s–d electrons and α is a certain constant given by the pairing interaction, the density of states and the cutoffs. Besides, if $\omega_{ss} = \omega_{dd} \neq \omega_{sd}$ ($\omega_{ss} = \omega_D$), V_{ss} $V_{dd} < V_{sd}^2$ and $\alpha > 1$, there may exist the phase transition of some kind (maybe of first order) at a certain impurity concentration, where V_{ss}, V_{dd} and V_{sd} are the strength of the pairing interactions. Thus it is noted that the choice of the cutoffs of the pairing interactions is physically important for the study of superconducting transition metals. (auth)

47173 TEMPERATURE DEPENDENCE OF THE JUMP OF THE DEFORMATION STRESS IN A SUPERCONDUCTING TRANSITION. Pustovalov, V. V.; Fomenko, V. S. (Physical-Technical Inst. of Low Temperatures, Kiev). JETP Lett. (USSR) (Engl. Transl.); 12: 10-12(5 Jul 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 15-18 (5 Jul 1970).

The character of the temperature dependence of the deformation-stress jump was investigated as the metal goes from the superconducting to the normal state. The transition at each measurement temperature was realized by turning on and off the magnetic field of a superconducting solenoid, inside of which the sample was continuously deformed. The samples investigated were 99.9995% pure Pb and 99.999% pure In. The experimental data do not confirm the statement that the temperature dependence of the stress jump is the same as the temperature dependence of the critical magnetic field of the superconductor. (M.H.R.)

47174 RELATION BETWEEN THE SUPERCONDUCTING PROPERTIES OF THE Ti–Nb–Fe ALLOY AND THE PARAMETERS OF THE NGR SPECTRA. Prokoshkin, A. F.; Puzei, I. M. JETP Lett. (USSR) (Engl. Transl.); 11: 336-9(20 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 493-7(20 May 1970).

An attempt was made to establish a relation between the critical current density (the macroscopic parameter most sensitive to the change of the microstructure of the alloy) and the nuclear gamma-resonance (NGR) spectrum parameters, which reflect this change directly. A titanium-based alloy with 38 at. % Nb and 5 at. % Fe was investigated. The NGR spectra were obtained at room temperature. The critical current density was measured at T = 4.2°K. Plots of critical current density vs the magnetic field at different temperatures are shown. The NGR spectra for samples subjected to cold deformation and annealed at different temperatures are presented. Plots of the relative area under the second line of the NGR spectrum, chemical shift of the second line, and critical current density in a field $H = 0.9\ H_{c2}$ as functions of the annealing temperature are shown. A preliminary discussion of the results is given. (M.H.R.)

47175 LONGITUDINAL ULTRASONIC ATTENUATION IN TYPE II SUPERCONDUCTORS: CLEAN LIMIT. Cerdeira, Hilda A.; Cottingham, W. N.; Houghton, A. (Brown Univ., Providence). J. Phys. Chem. Solids; 31: 1681-5(Aug 1970).

The attenuation of longitudinal sound in clean type II superconductors, near H_{c2}, was calculated using a nonperturbative

method. It is shown that, at low frequencies, the attenuation rate depends strongly on the direction of propagation of the wave and on impurity concentration. (auth) (UK)

47176 ULTRASONIC ATTENUATION IN A TYPE II SUPERCONDUCTING ALLOY. Tittmann, B. R. (North American Rockwell Corp., Thousand Oaks, Calif.). J. Phys. Chem. Solids; 31: 1687-91(Aug 1970).

Ultrasonic attenuation measurements have now been obtained on a magnetically reversible type-II superconductor with both a high Ginsburg–Landau parameter ($\kappa_G > 1$) and with BCS coherence length > electronic mean free path. For applied fields close to H_{c2}, the data appear to agree with dirty-limit ($\xi_0/l \gg 1$) theory which predicts a linear dependence of α on H. At fields farther from H_{c2}, α(H) deviates from linearity and appears to fit empirically to a parabolic function of H. At very low fields, $H \gtrsim H_{c1}$ the H- and T-dependence is in apparent agreement with another theory. Physical insight into the behavior in this region could be obtained with a model in which vortices are replaced by cylinders of completely normal material imbedded in a superconducting matrix. (auth) (UK)

47177 HYPERSONIC ATTENUATION IN NIOBIUM IN THE MIXED STATE. Lange, James N. (Oklahoma State Univ., Stillwater). J. Phys. Chem. Solids; 31: 1693-1700(Aug 1970).

The hypersonic attenuation of longitudinal and transverse modes in niobium is observed throughout the mixed state. The field dependence of the attenuation is shown not to be directly dependent on the normal state volume in the mixed state. The transverse and longitudinal attenuation have similar field dependences with the longitudinal mode coupling more strongly than the transverse mode to the vortices. The frequency and conductivity dependence of the phonon attenuation in the Meissner state exhibits features that are not strictly similar to the behavior of the attenuation in insulators, and might be associated with the coupling of the pair states to the lattice. (auth) (UK)

47178 JUSTIFICATION OF THE QUANTUM HYDRODYNAMICAL MODEL FOR A DILUTE SOLUTION OF IMPURITIES IN He II. Winter, Hermann (Max-Planck Institut fuer Physik und Astrophysik, Munich). Z. Phys.; 238: 110-20(1970).

Starting with a particle description for the system, the damping of the impurity quasi particles and their Boltzmann equation are derived microscopically. It is possible to add up all the terms to the qualitative and quantitative different contributions of the quantum-hydrodynamical model and to justify it in this manner. (auth)

47179 COOLING SPACER STRIP FOR SUPERCONDUCTING MAGNETS. Kassner, David A. (to United States Atomic Energy Commission). U. S. Patent 3,514,730. 26 May 1970. Filed 27 Mar 1968.

A cooling spacer strip is described for receiving a cooling fluid for circulating it in a uniformly fine network of small, rectangular cross section, mutually perpendicular streams that communicate with each other in a helically wound maze having transverse openings for contacting the fluid with the face of a helically wound, edge cooled superconductor strip. The cooling spacer strip also provides an easily fabricated, helically wound, uniformly fine, grid shaped matrix for supporting the superconductor strip in a large bore, high-field, superconducting magnet. (auth)

47180 FLUCTUATIONS IN HIGH-FIELD SUPERCONDUCTORS. Fulde, Peter (Univ., Frankfurt am Main); Maki, Kazumi. Z. Phys.; 238: 233-48(1970).

Calculations are presented for the influence of fluctuations in high-field superconductors where the critical field is limited by Pauli paramagnetism. Due to the fact that the critical field at the second-order phase transition point as a function of temperature may have a maximum at $T \neq 0$, the additional conductivity due to fluctuations may have a nonmonotonic temperature dependence. This way recent experimental findings by Tedrow, Meservey and Schwartz can be accounted for. The additional tunneling density of states due to fluctuations is also calculated. Under proper conditions it exhibits a maximum at zero frequency like in the gapless regime. Finally, it is shown that the findings of a nonmonotonic resistivity should also apply to superconductors containing magnetic impurities in an external field. (auth)

47181 SPECIFIC HEAT OF RHENIUM BETWEEN 0.15 AND 4.0 K. Smith, David Reeder. Lafayette, Ind.; Purdue Univ. (1969). 67p. University Microfilms Order No. 70-8973. Thesis.

The specific heat of rhenium was measured in the normal state between 0.15 and 4.0 K and in the superconducting state between 0.3 and 4.0 K. The motivation was to investigate the Schottky anomaly in the specific heat due to the interaction of the nuclear quadrupole moment with the crystalline field, for a high-purity (99.995%) specimen. The specific heat in the normal state between 0.15 K and 4.0 K was found to be $C_n = \gamma T + \alpha T^3 + A/T^2$, where $\gamma = 2280 \pm 20$ μJ/mol/deg^2, $\alpha = 27 \pm 2$ μJ/mol/deg^4, and $A = 49 \pm 2$ μJ/deb/mol. Below $T_c = 1.699$ K, the electronic contribution to the specific heat in the superconducting state was found to be $C_s = \gamma T_c a \exp(-bT_c/T)$ where $a = 8.14$ and $b = 1.413$. The above parameters were consistent with the vanishing of the entropy difference $S_n - S_s$ at T_c. The value of the Debye temperature at absolute zero, $\theta_o = 416$ K, agrees with the value derived from measurement of elastic constants. The density of states at the Fermi level, N(ξ), derived from the measured value of γ, is 0.484 states of one spin per eV atom. The value for the superconducting energy gap derived from the value of b deduced in this work is 3.43 kT_c, compared to a value of 3.30 kT_c deduced from thermal conductivity measurements. The critical field parameter, H_c, was found to be 210 oersteds, and the deviation of the critical field curve from parabolic dependence was less than 3.8%. The resonant frequencies corresponding to the interaction between the nuclear quadrupole moment with the crystalline field were found to be 41 and 82 MHz. (Diss. Abstr. Int., B)

47182 LOW-TEMPERATURE SUSCEPTIBILITY OF THE COMPOUND C_8K BY ELECTRON SPIN RESONANCE. Poitrenaud, J. (CEN de Saclay, Gif-sur-Yvette, France). Rev. Phys. Appl.; 5: 275-81(Apr 1970). (In French).

The paramagnetic susceptibility of C_8K was measured as a function of the temperature from 300°K to 0.4°K and the intensity of the conduction electron spin resonance was studied. C_8K was found to have a metallic behavior. Various samples of C_8K were investigated for superconductivity down to 0.3°K, but no transition could be found. The device (a 300-MHz spectrometer, a ^{3}He cryostat, and a low-frequency superconductivity detection bridge) is described in detail. (tr-auth) (auth)

47183 EFFECT OF FLUCTUATIONS IN THE SUPERCONDUCTING ORDER PARAMETER ON THE ELECTRONIC STATES. Takayama, Hajime (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1445-57(Jun 1970).

The effect of fluctuations in the superconducting order parameter on the electronic states is examined at the dirty limit from the viewpoint of the microscopic theory in the classical range where the Aslamazov–Larkin approximations are valid. It gives rise to the effective existence of the order parameter and the renormalization of the relaxation time of electronic excitations. The electronic density of states, $n(\omega)$, deviated from its normal-state value is calculated. Correct treatments of the effects of impurities are essential in obtaining the right results. The depression of $n(\omega = 0)$ is proportional to $t^{-\frac{1}{2}}$ and t^{-1} for the three- and two-dimensional samples, respectively, t being the reduced temperature $t = (T - T_c)/T_c$. It is consistent with the experiment by Cohen et al. However, some discrepancies remain concerning the magnitude of the depression and the ω dependence of $n(\omega)$. The range in which the Aslamazov–Larkin approximations are appropriate is also discussed. (auth)

47184 CHANGE IN VELOCITY OF HIGH-FREQUENCY TRANSVERSE SOUND AT THE SUPERCONDUCTING TRANSITION TEMPERATURE. Stevens, J. L.; Houghton, A. (Brown Univ., Providence). J. Phys. Chem. Solids; 31: 1677-9(Aug 1970).

The change in velocity of transverse sound at the transition temperature consists of two parts: (1) a static part (usually estimated to be 1 to 10 ppm arising from the difference in the elastic constants between the superconducting and normal states, and (2) a purely dynamical effect due to Meissner screening of the transverse electromagnetic fields at the transition temperature. It is shown that under suitable conditions, as first suggested by Ozaki and Mikoshiba (1966), the second mechanism can give rise to much larger changes in the velocity of high-frequency sound. In fact, for Al at a sound wave frequency of 10^8 c/s and $ql = 10$ (here q is the wave number of the sound wave and l is the electron mean free path) the relative change in velocity can be as much as 1 part per thousand. The results of a detailed microscopic calculation of the relative change in velocity $(v_n - v_s)/v_n$ are presented for weak-coupling type-I superconductors. (auth) (UK)

47185 USE OF A SUPERCONDUCTING SOLENOID FOR NUCLEAR PARAMAGNETIC RESONANCE STUDIES. Alekseevskii, N. E.; Krasnoperov, E. P. (Inst of Physical Problems, Moscow). Dokl. Akad. Nauk SSSR; 190: 1325-8(21 Feb 1970). (In Russian).

In order to be able to study nuclei which require magnetic fields exceeding 25 k oersteds by NMR methods, a wide-line spectrome-

ter was built with superconducting components. The homogeneity of the magnetic field created by the superconducting solenoid was checked by measuring the location of the NMR lines of ^{63}Cu. The field was adjusted by means of a magnetic or superconducting plunger moved within a small winding. The field was modulated by a single-layer superconducting winding placed at the opening of the solenoid. The low inductance of this winding made of 0.1-mm-dia Nb_3Sn wire made it possible to supply it from either an ac or a dc source without using any choke coil. A Pound–Knight circuit was used as the indicator in the magnetic system; the generator frequency could be stabilized with an accuracy of ±0.5 kHz at a frequency between 5 and 30 MHz. In order to carry out measurements within a wide temperature range, from 1.2 to 200°K, the circuit was placed in a Dewar flask, changing the temperature by means of a constantan heating element and controlling it with an Au + 2.1% Co/Cu thermocouple. Operation of the device is illustrated by presenting the lines of ^{27}Al; the results agreed with data reported in the literature. (TTT)

47186 MAGNETIC INSTALLATIONS USED IN NUCLEAR PHYSICS. Bronca, G.; Hamelin, J.; Penicaud, J. P. (CEN de Saclay, Gif-sur-Yvette, France). Energ. Nucl. (Paris); 12: 143-8(Mar-Apr 1970). (In French).

The different types of magnets used in nuclear physics, their design and realization are described. Techniques are always improving and superconducting materials are of primary importance. (France)

Plasma and Thermonuclear Physics

47187 (NYO-3782-4) PROPERTIES OF THE HIGH BETA PLASMA STATE. Progress Report, August 1, 1969–July 31, 1970. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). Contract AT(30-1)-3782. 431p. Dep. CFSTI.

Separate abstracts were prepared for the 14 of the 15 sections of the progress report. One section was previously abstracted in NSA 24: 3402. (M.O.W.)

For abstracts of individual sections see: 47219, 47235–47239, 47264–47267, 47277–47279, and 47666.

Confinement and Heating

Refer also to abstract 46424.

47188 (AEC-tr-7157) POSSIBLE MECHANISM OF PLASMA DIFFUSION IN STELLARATOR L-1. Berezhetskii, M. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report CONF-690619-15. 6p. Dep. CFSTI.

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 5151.

47189 (AEC-tr-7160) PLASMA HEATING WITH STRONG ELECTRON BEAMS IN A MIRROR-TYPE MAGNETIC TRAP. Demirkhanov, R. A.; Govorkov, A. K.; Popov, A. F.; Pokhanka, Ya. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Sukhumi. Fiziko-Tekhnicheskii Institut). Translation of report NP-18059. 31p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 6509.

47190 (EUR-CEA-FC-552) COLLISIONAL LOSSES AND AMBIPOLAR POTENTIAL IN OPEN-ENDED MAGNETIC TRAPS. Brambilla, M.; Werkoff, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Jun 1970. 28p. (In French). Dep. CFSTI (U. S. Sales Only).

Principal results obtained in the literature on collisional losses in open-ended magnetic traps are briefly reviewed, with particular concern for the dependence of the confinement time on the mirror ratio. The simple theory neglecting the ambipolar potential is considered. This potential is then evaluated. Its effects on the distribution function and the confinement time are discussed. (tr-auth) (France)

47191 (LA-tr-70 18) MEGAGAUSS MAGNETIC FIELDS. Szpilecki, J. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Postepy Fiz.; 19: 411-30(1968). 22p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 1368.

47192 (ORNL-TM-3121) IMP ADIABATICITY. Colchin, R. J.; Ferguson, E. A. (Oak Ridge National Lab., Tenn.). Aug 1970. 45p. Dep. CFSTI.

The adiabaticity of protons injected into the mirror-quadrupole fields of the IMP device is studied by computer orbit following. Trapped 20-keV protons were found to be adiabatic at full (20 kG) fields. For half-field operation, nonadiabaticities were observed only at the largest trapped radii. (auth)

47193 POSSIBILITY OF HEATING IONS IN A PLASMA BY EXCITING DRIFT–BEAM INSTABILITY WITH A FEEDBACK SYSTEM. Arsenin, V. V. JETP Lett. (USSR) (Engl. Transl.); 11: 342-4(20 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 500-3 (20 May 1970).

The buildup of drift-beam (collisionless current-convective) instability in a magnetized plasma subjected to an electron beam is accompanied by heating of the plasma ions to a temperature on the order of the electron energy in the beam. The concentration of the plasma that can be heated in this manner is limited. It is shown that by using special electronic circuitry (a feedback system) that measures the oscillations of the electric field and controls the beam current, it is possible to excite drift-beam instability in a plasma that is much denser than in the absence of feedback. Since the spatial structure of the oscillation is the same in this case, and the increment is of the same order, as in the natural instability (without the feedback), and since it is immaterial for particle acceleration what causes the acceleration field, heating can be expected at sufficiently large oscillation amplitudes. Since there is no linear theory, nor is there one for the natural instability, the oscillation level required for the heating can be established only experimentally. (J.C.W.)

47194 PLASMA HEATING BY OPPOSING BEAMS OF COHERENT RADIATION. Zel'dovich, Ya. B.; Levich, E. V. (Applied Mathematics Inst., Moscow). JETP Lett. (USSR) (Engl. Transl.); 11: 339-42(20 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 497-500(20 May 1970).

A proposal is presented for plasma heating by the use of opposing beams, one or both of which are spectrally broad ($\Delta\nu/\nu \geq v/c$, where v is the thermal velocity of the electrons). Strictly speaking, light with this $\Delta\nu$ cannot be called coherent, but the required intensity can be attained only by somehow broadening the coherent radiation. Only with such a spectrum do the electrons have a Maxwellian distribution with respect to the longitudinal velocity as a result of interaction with light without collisions. The heating rate is proportional in this case to the product of the intensities of the two beams and does not depend on the charge of the nucleus or on the plasma density. The heating of free electrons by the Compton mechanism is discussed and compared with the bremsstrahlung mechanism. A classical interpretation of heating by stimulated scattering is presented and compared with acceleration of waves by opposing beams. A similarity can be seen between the proposed heating method and the suggested coherent acceleration of plasmoids and particles in opposing radiation beams. (J.C.W.)

47195 UNDERSTANDING TURBULENT ION HEATING IN THE OAK RIDGE MIRROR MACHINE, BURNOUT V. Alexeff, I.; Estabrook, K.; Hirose, A.; Jones, W. D.; Neidigh, R. V.; Olsen, J. N.; Scott, F. R.; Stirling, W. L.; Widner, M. M.; Wing, W. R. (Oak Ridge National Lab., Tenn.). Phys. Rev. Lett.; 25: 848-51(28 Sep 1970).

For several years, steady-state, mirror-confined hot-ion plasmas with $T_i \approx$ a few keV and $n_i \approx 10^{13}/cm^3$ have been produced. The ion-heating mechanism is described here, which is an instability having a fine-grained azimuthal structure covering a broad band of frequencies around ω_{pi}, having a rapid growth rate on the order of ω_{pi}, and being driven by an intense radial dc electric field. It does not require that $T_e > T_i$. (auth)

47196 PLASMA HEATING BY ULTRASHORT LASER PULSES IN THE PROCESS OF ELECTRONIC HEAT CONDUCTION. Zakharov, S. D.; Krokhin, O. N.; Kryukov, P. G.; Tyurin, E. L. (Lebedev Inst. of Physics, Moscow). JETP Lett. (USSR) (Engl. Transl.); 12: 36-8(5 Jul 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 47-50 (5 Jul 1970).

The heating of ions in a laser-created plasma by ultrashort (10^{-11} to 10^{-12} sec) laser pulses is considered for absorbed-energy density $\epsilon > \epsilon_k \simeq 6 \times 10^3$ J/cm². The duration of the ultrashort pulse is shorter than the characteristic plasma times. After the termination of the laser pulse, a plane electronic thermal wave propagates in the interior, and the heat-conduction wave front leads the rarefaction wave. From the heat-conduction, energy-conservation, and electron–ion relaxation equations, the ion temperature increases with energy absorption; thus, the heat-conduction heating is effective. Neutron yields are calculated for D and LiD. (D.L.C.)

47197 ELECTRON SHOCK WAVES IN A COLLISIONLESS PLASMA. Ivanov, A. A.; Rusanov, V. D.; Sagdeev, R. Z. JETP Lett. (USSR) (Engl. Transl.); 12: 20-2(5 Jul 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 29-31 (5 Jul 1970).

Under conditions of anomalous resistance, the spreading of a bunch of hot electrons can lead to the formation of a stationary moving jump of the density of the hot electrons. Conditions for this jump are obtained from conservation laws, resulting in a nonlinear wave equation. The velocity and width of the jump and the form of the distribution function are discussed. (D.L.C.)

47198 PLASMA LOSSES IN A TOROIDAL THETA PINCH WITH SUPERPOSED HEXAPOLE. Junker, J.; Lotz, W. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys.; 238: 148-58(1970).

A toroidal theta-pinch discharge with superposed non-helical hexapole field is investigated. The characteristic data of the discharge are: major diameter 52 cm, minor inner diameter of the vacuum vessel 6 cm, maximum magnetic field between 10 and 21 kG, rise time (quarter-cycle) 3.0 μs, maximum temperature between 40 and 100 eV, maximum density between 1 and 3×10^{16} cm^{-3}, beta-values between 0.3 and 1. The plasma confinement times are determined by measuring particle density, temperature, and plasma radius. The confinement times are compared with those of models which account for cusp losses, resistive losses, and Bohm diffusion. Measured confinement times are consistent with those expected from cusp losses with a cusp slit-width of one ion gyro-radius. Above electron temperatures of 20 eV, resistive losses are negligible. Bohm diffusion is not consistent with measurements, but is of the same order of magnitude. (auth)

47199 EFFECT OF MAGNETIC PERTURBATION ON THE MAGNETO-ACTIVE PLASMA. Singh, R. P.; Singh, R. N. (Banaras Hindu Univ., India). Nuovo Cim.; 68B: 44-52(11 Jul 1970).

The effect of magnetic perturbation on the magneto-active plasma is considered. The collisionless Boltzmann transport equation is solved for an assumed perturbation in the Maxwellian velocity distribution function. An expression for energy transfer is derived in terms of perturbed distribution function. Using the magnitude of perturbation for certain astrophysical and laboratory conditions, the heating or cooling of the magneto-active plasma is studied. (auth)

47200 CYCLOTRON HEATING OF PLASMA IONS AND ELECTRONS BY HIGH-FREQUENCY FIELDS. Galaktionov, B. V.; Novik, K. M.; Podushnikova, K. A.; Poloskin, B. P.; Shcherbinin, O. N. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1059-62(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1411-15(Aug 1969).

The independent heating of plasma electrons and ions under the influence of fields with frequencies close to the electron and ion cyclotron frequencies was studied. Waves can be excited at both the ion cyclotron frequency and its harmonics in a plasma produced by the electron cyclotron resonance. The absorbed power is evaluated. (auth)

Diagnostics

Refer also to abstract 46425.

47201 (AEC-tr-7166) LASER APPLICATIONS FOR HIGH-SPEED INVESTIGATIONS OF FAST PROCESSES. Sklizkov, G. V. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report FIPNL-29. 33p. Dep. CFSTI.

A review-type discussion for the use of lasers as light sources is given: (1) photography in slit scanning mode, (2) frame photography with photorecorder frame separation, (3) frame photography with light delay, (4) ultrashort exposures, (5) fast optical shutters, (6) laser plasma as a light pulse source, (7) high-speed interferometric photography, and (8) high-speed Schlieren photography. (M.O.W.)

47202 (IPPJ-DT-16) CONSTRUCTION IN TRIAL OF THE DIGITAL CORRELATION MEASURING DEVICE WITH A BROAD FREQUENCY-REGION SWEEPING, AND MEASUREMENT OF ELECTRON-DENSITY CORRELATIONS IN A REVERSE-BRUSH-CATHODE PLASMA. Tsukishima, Takashige; Iwama, Naofumi (Nagoya Univ. (Japan). Inst. of Plasma Physics). Mar 1970. 30p. (In Japanese). Dep. CFSTI (U. S. Sales Only).

Some three years after the start of joint studies on correlation measurements in a plasma, a digital correlation measuring device, covering 1 to 15 MHz, of the frequency-sweeping type was completed. Subsequently, an intermediate amplifier was provided to cover 100 KHz to 1.5 MHz, ending a sweeping over 100 KHz to 15 MHz. Along this line, a plasma source of the reverse-diffusion type and a reverse-brush-cathode plasma were also prepared. At present classic diffusion coefficients are obtained from the measurement of density correlations in a reverse-brush-cathode plasma. The digital correlation measuring device consists of amplifying and data logger sections. The former section is divided into two systems depending on the frequency values. In this section, the two input signals are frequency-converted, and the outputs are fed to the data logger section. In the latter section, to measure the correlation between two signals from the amplifying section, A-D conversion, digital multiplication, sampling, etc., are performed. The output data are retained as digital quantities in a memory circuit, which then can be drawn out by connecting a tape perforator to it. (Japan)

47203 (ORNL-TM-3128) METHOD OF MEASURING THE POLOIDAL MAGNETIC FIELD IN DIFFUSE TOROIDAL PINCHES. Murakami, M.; Clarke, J. F. (Oak Ridge National Lab., Tenn.). Aug 1970. 11p. Dep. CFSTI.

A method of using the Thomson scattering of a CO_2 laser beam is proposed to measure the poloidal magnetic field produced by the plasma current in diffuse toroidal pinches of the Tokamak type. The method is based on resolving the relative shape of the cyclotron lines, whose broadening is introduced by "misalignment" due to the poloidal field with respect to the large toroidal magnetic field on which the scattering system is aligned. (auth)

47204 ELECTRON-DENSITY PROFILES OF A THETA-PINCHED PLASMA BY HOLOGRAPHIC INTERFEROMETRY. Nicholson, J. P.; Hogan, A. F.; Irving, J. (Univ. of Strathclyde, Glasgow). J. Phys., D (London); 3: 1387-91(Sep 1970).

A determination of electron densities in a θ-pinch plasma by holographic interferometry is described. By careful holographic reconstruction techniques the radial variation of z-integrated electron density from the axis of the discharge tube was measured to relative accuracies of order 2%. A peak electron density of $n_e = (2.6 \pm 0.3) \times 10^{16}$ cm^{-3} was obtained near to maximum compression for hydrogen filling pressures of 20 mtorr. Reconstruction of the interferograms at different angles yielded information on the axial extension of the plasma, which showed that the plasma extended considerably past the region of the θ-pinch coil. (auth) (UK)

47205 LANGMUIR-PROBE MEASUREMENT OF ELECTRON TEMPERATURE IN A FLOWING HIGH-DENSITY PLASMA. Clements, R. H. (Univ. of Victoria, British Columbia); Smy, P. R. Electron. Lett.; 6: 538-9(20 Aug 1970).

Measurements with cooled double probes in a propane-air flame show that the measured electron temperature and the floating voltage of the probes can be strongly affected by variation of the probe temperature. Simple theoretical considerations indicate that these effects arise from cooling of the plasma electrons by collisions with cold molecules in the hydrodynamic boundary layer surrounding the probe. (auth) (UK)

47206 DETERMINATION OF THE CROSS SECTION $\sigma(Cs^+ \rightarrow Cs)$ FROM LANGMUIR-PROBE MEASUREMENTS IN A THERMAL Cs PLASMA. Fuchs, G. (Univ., Marburg, Ger.). Z. Phys.; 237: 427-31(1970). (In German).

The ion current I_i to a Langmuir probe was measured in a Cs-plasma produced by contact ionization, the neutral density n_a being known and the plasma density given by the Saha equation. Using the theory of Self and Shih, the collision cross section $\sigma(Cs^+ \rightarrow Cs)$ is calculated from the measured ion current I_i. (auth)

47207 COAXIAL, THREE-COIL PROBE FOR MEASURING LOCAL VALUES OF ELECTRICAL CONDUCTIVITY AND VELOCITY IN PLASMA STREAMS. Vendell, Edward W. (Utah State Univ., Logan); Posch, Rudolph E; Cook, George R. ; AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1399-1404(Aug 1970).

A primary coil excited by 100-kHz current is located between two secondary sensing coils. In an axisymmetric plasma stream with magnetic Reynolds numbers less than unity, changes in the induced sum and difference voltages are simultaneously detected and linearly related to local values of conductivity σ and velocity U by means of an analysis based on Ohm's law and Maxwell's equations. In electrolytes σ was within 5% of standard conductivity cell readings for four probe models having different outside diameters (4 mm minimum) and coil spacings (1.14 cm minimum). Each probe was tested in a free, 16.5-cm-OD, argon plasma jet that was created as the gas expanded from 1.0 to 5×10^{-4} atm through a 1.27-cm-diam constricted arc. The resulting measured centerline values of σ ranged from 300 to 900 mho/m whereas the corresponding values of U varied from 3.5 to 8 km/sec and agreed within 8% of independent values computed from flow-swallowing mass and enthalpy probes. Although test Mach numbers ranged from 3 to 6, the effect of possible oblique shocks was negligible since the probe Knudsen numbers were near unity. Corrections calculated from theory for stream diameter and finite probe size

were small and brought the results from the various probe sizes into closer agreement. (auth)

47208 LANGMUIR PROBE RESPONSE IN A TURBULENT PLASMA. Peterson, E. W.; Talbot, L. (Univ. of California, Berkeley). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1391-8(Aug 1970).

A theoretical and experimental investigation of the response of collisionless cylindrical Langmuir probes in unsteady plasmas is made with the specific aim of developing methods for measuring the mean and statistical plasma properties. A comprehensive theory describing the transient responses of both single probes and symmetric double probes to arbitrary (low-frequency) fluctuations in electron density, plasma potential, electron temperature, and ion temperature is formulated by perturbing the probe steady-state equations about the mean plasma properties. The ratios of probe radius to Debye length and applied potential to electron temperature are used as controllable parameters to form a set of equations from which the mean and rms properties may be determined. Experiments are performed in an unsteady highly expanded low-density flowing argon plasma. Pertinent features of the theory are verified and quantitative measurements of the mean and fluctuating plasma properties are made. (auth)

47209 ISSLEDOVANIE PLAZMY S POMOSHCH'YU LAZEROV. (Use of Lasers in Plasma Research). Dushin, L. A.; Pavlichenko, O. S. Moscow; Atomizdat (1968). 144p.

The development of the optical quantum generators (lasers) widens the opportunity for the investigation of plasma. The lasers are used in interferometric measurements for the determination of the atomic distributions and electron density in plasmas. The theory and experimental investigations of the scattering of light by plasma is reviewed. Investigations of plasma with lasers are very specific, and an attempt is made to generalize the theoretical and experimental results. 198 references. (tr-auth)

47210 INVESTIGATION OF SHOCK FORMED IN THE FLOW OF PLASMA INTO A MAGNETIC FUNNEL. Dean, Eugene Alan. College Station, Tex.; Texas A and M Univ. (1969). 89p. University Microfilms Order No. 70-9679.

Thesis.

Thomson scattered laser light from plasma was used to determine the time resolved electron density and temperature of the shock formed in the axial injection of plasma into a dipole magnetic field. These measurements were obtained in a region upstream from the throat of the magnetic funnel for low-β hydrogen, deuterium, and helium plasmas accelerated by a conical pinch tube. The observed increase in electron temperature cannot be explained by compression since the temperature peak occurred prior to the maximum density. A hybrid shock involving a collisionless transfer of longitudinal to transverse ion energy due to the magnetic field gradient and electron heating due to Coulomb collisions with ions is consistent with the observed electron temperature and density time history. The thermalization of cold electrons and hot ions is shown to be sufficiently fast to provide the observed increase in entropy across the shock front. (Diss. Abstr. Int., B)

47211 PULSED LANGMUIR PROBE MEASUREMENT OF IONIZATION IN A HIGH-PRESSURE PLASMA. Clements, R. M. (Univ. of Victoria, British Columbia); Smy, P. R. IEEE (Inst. Elec. Electron. Eng.), Trans. Instrum. Meas.; IM-19: 167-71 (Aug 1970).

Measurements with a negatively pulsed probe in an atmospheric-pressure high-density plasma over wide ranges of ionization density (10^{15} to 10^{18}/meters^3), probe voltage (10 to 400 volts), and flow velocity (5 to 40 m/s) have confirmed previous results obtained by Thomas, working at a single voltage and flow velocity in which the current initially falls off with a t^{-y} dependence where $y \approx 0.58$ and t = time. The results together with those of Thomas show good agreement with a theory based on a physical model involving space-charge controlled expansion of the sheath towards its final position. It is expected that this technique of probe operation will afford a simple and sometimes unique method of measuring ionization density with excellent spatial resolution, under high-pressure conditions where the plasma velocity relative to the probe is not accurately known (for atmospheric-pressure dc measurements this factor often becomes significant with flow velocities >0.1 to 1 m/s). (auth)

47212 THEORY OF AN ELECTROSTATIC PROBE IN A STATIONARY QUIESCENT PLASMA. Chang, Kuo-wei. Princeton, N. J.; Princeton Univ. (1969). 137p. University Microfilms Order No. 70-8352.

Thesis.

The electrical effects of a biased sphere immersed in a weakly ionized gas of infinite extent are analyzed on the basis of kinetic theory. Solutions are obtained by the application of a moment method in which the velocity space is split according to an exact orbit calculation, self-consistent with the field. Results are shown to reproduce both the collisionless and the continuum solutions in the appropriate limits. A detailed asymptotic analysis is performed for small Debye length but arbitrary mean free path and criteria for the collisionless or collision-dominated sheath are obtained explicitly. The current–voltage characteristics are presented in a form useful for direct prediction of electron number density in terms of measured current and voltage, provided the mean free path is known. If the mean free path is only estimated, the results can be used directly to check self-consistency of that estimate. Typical results obtained from quantitative calculations are presented for a completely absorbing probe surface biased to a highly negative potential. A general theory is also presented for an electron-emitting probe in the collisionless and the transition regimes. The structure of the resulting double sheath is analyzed in detail. A simple method is developed which facilitates the solution of the space-charge-limited emission problem. Typical numerical results for the space-charge-limited current and the current–voltage characteristics are also given. (Diss. Abstr. Int., B)

47213 SPATIAL VARIATION OF ELECTRON ENERGY IN A HF RING DISCHARGE. Eidmann, K. (Univ., Marburg, Ger.). Z. Phys.; 238: 189-94(1970).

The electron temperature is measured in inductively coupled high-frequency gas discharges in Ar, Kr, and Xe with the aid of Langmuir probes. The measured temperature shows a rather low radial space dependence up to values of $pR \approx 30$ torr cm (p = gas pressure, R = radius of the discharge vessel). This behavior is explained on the basis of the local energy balance of the electrons as a consequence of the energy transport by thermal conduction in the electron gas. (auth)

47214 PLASMA DENSITY AND TEMPERATURE MEASUREMENTS IN THE AFTERGLOW OF AN AXIAL DISCHARGE USING DOUBLE ELECTRIC PROBES. Martone, M. (EURATOM–CNEN, Frascati, Italy). Nuovo Cim.; 68B: 91-99(11 Jul 1970).

Double electric probes (d.e.p.) with dc and pulsed bias voltage were used to measure radial profiles of density and temperature in the afterglow of a pulsed axial discharge in a regime where collisions are important (H_2, 25 m torr). The relative-density measurements with d.e.p. were calibrated by means of density measurements by Stark broadening on the axis of the discharge. (auth)

47215 SPATIAL DISTRIBUTIONS IN A SYNTHESIZED PLASMA BEAM. Golovanivskii, K. S.; Lushchik, A. I. (Patrice Lumumba Univ., Moscow). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1085-8(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1446-51(Aug 1969).

Measurements were made of the longitudinal and transverse distribution of electron temperature, the electrostatic field, and the ion current density in a synthesized cesium plasma. The energy spectra of electrons and ions along the beam and transverse to it were investigated. It was found that there are two groups of electrons, with temperatures of the order of 0.2 and 4 eV, in the neutralized beam. The plasma beam has a complex radial structure as regards current density and ion energy. Possible mechanisms for the observed phenomena are suggested. (auth)

47216 DETERMINATION OF PLASMA DRIFT VELOCITY BY AN ION–ACOUSTIC WAVE TECHNIQUE. Rehmann, Wilhelm K.; Stone, Noble H. (Marshall Space Flight Center, Huntsville, Ala.). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1717-18(Sep 1970).

A method is outlined that uses the transmission of ion–acoustic waves to determine the drift velocity of a streaming, collisionless N_2^+ plasma, which approximates the ionospheric conditions of ion mass and plasma density. Some examples of data are described. (M.O.W.)

Kinetics (General)

47217 (LA-tr-69-26(Draft)) [PLASMA IMAGES]. Haegi, Marcel (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy), Laboratorio Gas Ionizzati). Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from pp 59-74 of report LGI-68/16. 19p. Dep. CFSTI.

A study was made of a dense plasmoid undergoing intense z pinches. The correlations between the temporal evolution of the induced voltage, the soft and hard x radiation, neutrons, and the mean radius are described. Parameters of the plasmoid under different operating conditions are described. (M.O.W.)

47218 (NP-18414) INTERACTION BETWEEN A PLASMA AND A NEUTRAL GAS. Danielsson, Lars (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Jun 1969; Revised Dec 1969. 28p. Dep. CFSTI (U. S. Sales Only).

An experiment where a high-velocity plasma stream penetrates a stationary neutral-gas cloud in a magnetic field is described. It was found that the interaction between the plasma and the gas was far more violent than what can be expected from simple atomic interaction theories. The parameters are such that the character of the interaction is collisionless. The observations demonstrate that the plasma was very efficiently retarded as it penetrates into the gas cloud and that the electron energy distribution changes drastically towards higher energies, at least for a part of the population, resulting in partial ionization of the gas. In order to account for the observations it is necessary to assume some kind of collective interaction between the plasma and the neutral gas. The results are analyzed from the point of view of Alfvén's critical velocity hypothesis. (auth) (Sweden)

47219 (NYO-3782-4, App.4) COLLISION FREE SHOCK FORMATION IN FINITE TEMPERATURE PLASMAS. Auer, P. L.; Evers, W. H. Jr. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 33p.

From properties of the high beta plasma state.

A one-dimensional macro-particle code is used to investigate the effect of finite initial ion temperature on large-amplitude magnetosonic disturbances. Time-dependent piston problems closely related to the earlier work of Auer, Hurwitz and Kilb are studied. It is shown that at even relatively small plasma pressure to magnetic pressure ratios, large-scale turbulence due to orbit crossings produces quasi-stationary shocks for all values of Mach numbers investigated. This is in contrast with cold plasma results, where similar results were observed only if the Mach number was chosen well in excess of the critical value ($M_{A,cr.} = 2$). The mechanics of electron heating are not treated in this study. (auth)

Kinetics (Experimental)

Refer also to abstract 47206.

47220 (LRP-43/70) EXPERIMENTAL INVESTIGATION OF THE 90 MW ROTATING MAGNETIC FIELD PINCH. Berney, A.; Heym, A.; Hofmann, F.; Jones, I. R. (Centre de Recherches en Physique des Plasmas, Lausanne (Switzerland)). Jun 1970. 46p. Dep. CFSTI (U. S. Sales Only).

The results and interpretation of measurements made on the 90-MW rotating magnetic field pinch are presented. Three standard filling pressures of 20, 60 and 180 mtorr He were chosen, and the following measurements were made: streak and framing photography, electron line density profiles, electron and ion temperatures, and detailed magnetic probe measurements. (auth)

47221 (NP-18416) MEASUREMENTS OF CATHODE HEATING IN A PENNING DISCHARGE IN A STRONGLY INHOMOGENEOUS MAGNETIC MIRROR FIELD. Hopfgarten, N. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Feb 1969. 41p. Dep. CFSTI (U. S. Sales Only).

A technical description of the apparatus used for the measurements is described and a detailed description of a method for obtaining the results for the unsymmetric mode of burning is given, together with a discussion of the assumptions made. Mean ion densities in the range 10^{10} to 10^{11} cm^{-3} and mean ion energies between 1 and 5.5 keV were obtained. When the discharge was burning with one cathode on a high voltage and the other on a low voltage 60 to 70% of the current to the high-voltage cathode was carried by ions. The current of electrons to the low-voltage cathode was about 30 to 50% of the ion current. The current of electrons leaving this cathode depends strongly on the degree of asymmetry of the discharge. (auth) (Sweden)

47222 (NP-18422) EXPERIMENTS WITH AN ELECTRODELESS PLASMA ACCELERATOR. Lindberg, L. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Jul 1969; Revised Jan 1970. 30p. Dep. CFSTI (U. S. Sales Only).

Experiments with an electrodeless plasma gun (conical theta pinch) are described. The gun was intended as a plasma source for studies of collision between plasma and magnetic, solid, or gaseous obstacles. The plasma was shot out into an axial guiding magnetic field of the order 0.02 Vs/m^2. It was studied by means of electric potential probes, floating electric double probes, magnetic loops and probes, and an ion energy analyzer. Density, temperature, and velocity were of the order 10^{19} m^{-3}, 10^5°K, and 3×10^5 m/s, respectively. The plasma was emitted from the gun in a narrow time range. Three special features were studied: (a) a precursor plasma with very violent potential fluctuations; (b) the occurrence of a twisted structure of the guiding magnetic field; and (c) the formation of plasmoids or plasma rings. (auth) (Sweden)

47223 (TID-25509) TIME AND SPATIALLY RESOLVED SPECTRA OF EXPLODING WIRES. Mc Dermott, William Edward (California Univ., Davis). [1968]. 159p. Dep. CFSTI. Thesis.

An experiment that makes possible the simultaneous measurement of the edge-on intensity distribution and optical depth of a cylindrically symmetric plasma is described. The mathematical inversion procedures required to extract the distribution of the absorption and emission coefficients as a function of the radial position within the plasma are explained. The method is capable of obtaining these quantities as a function of wavelength over a wide spectral range and provides for resolution of these quantities as a function of time. A plasma produced by an exploding copper wire is viewed during the time period from 15 to 20 μsec after detonation. The emission and absorption coefficients are found as a function of radius for the outer 75% of the plasma. A temperature profile is obtained from these quantities assuming local thermodynamic equilibrium. The temperature profile exhibits a maximum temperature of about 12,800°K, approximately 0.6 of the distance between the plasma axis and outer edge. The temperature falls smoothly on either side of this maximum and reaches a low value of 9100°K at the outer edge and a value of 11,000°K at the innermost position measured (one-quarter of the distance between the plasma axis and outer edge). The behavior of the absorption coefficient indicated the presence of strongly broadened atomic lines. Attributing this broadening to the Stark effect enabled the extraction of a density profile. Integration of this density profile over the cross section of the wire yielded a value for the total number of atoms per unit length within 10% of the initial value. The density profile exhibits a minimum value at the position of maximum temperature. (auth)

47224 (UCRL-Trans-10478) GENERATION OF COHERENT RADIATION IN THE VISIBLE RANGE WITHIN PLASMA-BEAM DISCHARGE. Tkach, Yu. V.; Fainberg, Ya. B.; Bolotin, L. I.; Bessarab, Ya. Ya.; Gadetskii, N. P.; Magda, I. I.; Bogdanovich, A. V.; Chernen'kii, Yu. N. Translated for Lawrence Radiation Lab., Livermore, Calif., from Ukr. Fiz. Zh.; 14: 1470-5(Sep 1969). 11p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 24: 3350.

47225 MEASUREMENT OF ENERGY LOSSES OF FAST PROTONS IN A COLD PLASMA. Caby-Eyraud, Monique (CEN, Fontenay-aux-Roses, France). J. Phys. (Paris); 31: 445-9(May-Jun 1970). (In French).

The energy loss of fast (5 to 10 keV) protons in a cold lithium plasma ($n_e = 5 \times 10^{18}$ m^{-3}, $T_e \sim 1.5$ eV) was measured. Protons were created by dissociation of H_3^+ ions injected perpendicularly to the axis of the magnetically confined arc column. The proton azimuthal drift due to the radial gradient of the magnetic field increased the interaction length. The experimental values were in agreement with the predictions of the Fokker–Planck equation. (tr-auth) (France)

47226 NUMERICAL INVESTIGATION OF THE FREE EXPANSION OF A SUPERSONIC PLASMA JET HEATED AND ACCELERATED BY AN ELECTRIC ARC. Bergt, Wolfgang Hermann. Knoxville, Tenn.; Univ. of Tennessee (1969). 159p. University Microfilms Order No. 70-7547. Thesis.

The steady state, axisymmetric flow field of the free expansion of a supersonic plasma jet issuing from a sonic orifice is investigated numerically using continuum flow theory. The essential physical features of this expansion may be described as follows: The gasdynamic flow of the plasma is influenced by a coaxial, electrical arc discharge, which is accomplished between a tipped cathode located upstream of the sonic orifice, and a coaxial, ring-shaped anode positioned some distance downstream of the orifice. The possibility of stable operation of such a device has been proven experimentally by many investigators. The electrical discharge has two major effects on the plasma flow as a whole: (1) the plasma is constantly heated during its supersonic expansion due to the effects of Joule-Heating and (2) is accelerated due to self-induced Lorentz-Forces. (Diss. Abstr. Int., B) (TSS)

47227 EQUILIBRIUM PROPERTIES OF He–N_2, Ar–N_2, AND Xe–N_2 PLASMAS AT ATMOSPHERIC PRESSURE, BETWEEN 5,000°K AND 35,000°K. Capitelli, M.; Ficocelli, E.; Molinari, E. (Bari Univ., Italy). Rev. Int. Hautes Temp. Refract.; 7: 153-63(Apr-Jun 1970).

Equilibrium compositions, thermodynamic functions, total

specific heats, and specific heats of single species were calculated for He–N_2, Ar–N_2 and Xe–N_2 plasmas at atmospheric pressure between 5,000 and 35,000°K in the whole range of compositions. Partition functions were determined according to Griem's criterion after inclusion of the missing energy levels in the sets of observed levels reported by Moore. The influence of the insertion of the missing levels on the equilibrium properties of both species and mixtures was examined. In particular, the insertion of the missing levels brings about a dependence of the partition functions and of the specific heats of every species on the composition of the mixtures. This dependence is particularly strong in the case of the species N, N^+, and He. (tr-auth) (France)

Kinetics (Theoretical)

Refer also to abstracts 46904, 46998, 47199, 47267, and 47342.

47228 (CEA-N-1295) EFFECT OF COLLISIONS ON THE NONCOHERENT SCATTERING SPECTRUM OF A PLASMA HAVING UNEQUAL ELECTRONIC AND IONIC TEMPERATURES. Lepechinsky, Dimitri (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jul 1970. 55p. (In French). Dep. CFSTI (U. S. Sales Only).

Thesis. Submitted to Paris Univ., Orsay, France.

The method for calculating the spectrum scattered by a plasma in thermodynamic equilibrium in the presence of collisions, based on the generalized Nyquist theorem, is extended to the case of a plasma having unequal electronic and ionic temperatures. Various numerical applications of the expression obtained for the spectrum are presented, together with a comparison of recent experimental results on a laboratory plasma ($T_e \neq T_i$) with theoretical predictions. Good agreement exists between these predictions and the experimental spectra. Finally a method is presented for obtaining the electron and ion temperatures of the plasma from the shape of its spectra. (tr-auth) (France)

47229 (IPP-4/5) PARAMETRIC MOTION AND ITS EFFECTS ON PARTICLE DIFFUSION AND THE PLASMA DIELECTRIC CONSTANT. Puri, S. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany). Apr 1970. 12p. Dep. CFSTI (U. S. Sales Only).

A uniform electric field transverse to a spatially nonuniform magnetic field produces particle diffusion even when the electric field spectrum contains no dc component. This diffusion is additional to the usual E × B diffusion and occurs isotropically in the plane transverse to the magnetic field direction. The dielectric constant derived for the case of a uniform magnetic field is shown to be quite inappropriate for a plasma in a spatially nonuniform magnetic field. (auth)

47230 (IPP-6/84) CHARACTERISTICS OF THE SYSTEM OF STATIONARY PLASMA MACROSCOPIC EQUATIONS. Tasso, H. (Institut fuer Plasmaphysik, G.m.b.H. Garching (West Germany). Jan 1970. 8p. Dep. CFSTI (U. S. Sales Only).

The character of the system of stationary macroscopic equations including resistivity and viscosity was studied. The system can be split into five first-order subsystems and one single equation. The subsystems all have an elliptic character, and the single equation is responsible for the mixed character of the whole system. This mixed character could cause trouble for the boundary-value problem of stationary equilibrium even in axisymmetry, for which an example is given. It seems plausible that more refined systems (in example, with thermal conductivity) retain this mixed character. (auth)

47231 (NP-18406) TRANSVERSE IONIZING SHOCK WAVES IN A PLANAR ELECTROMAGNETIC SHOCK TUBE. Lee, Sing (Australian National Univ., Canberra). Oct 1969. 253p. Dep. CFSTI (U. S. Sales Only).

Thesis.

The Kunkel-Gross-Chapman-Jouguet hypothesis for the propagation of normal ionizing shock waves was adapted for the description of the transverse ionizing shock waves in the planar electromagnetic shock tube. This was made possible by the adoption of an ohmic dissipation model for the expansion wave, resulting in the choice of the isentropic sound speed as the small disturbance speed. The validity of this choice was established by bow shock measurements. Transverse ionizing shock equilibrium solutions were obtained, based on this C–J model, with extension to the hydromagnetic and the gasdynamic regimes. A new method of Mach–Zehnder interferometry, using multi channel spectra, was used to obtain more accurate measurements of the electron density and the density ratio than could be attained by conventional M–Z methods. An approximate probe theory was developed to account for the influence of the bow shock on the measurement of the transverse magnetic field and the total pressure. The preshock electric field was also measured. (auth)

47232 (NP-18420) ION SEPARATION EFFECTS IN THE BOUNDARY REGION OF A PLASMA SURROUNDED BY NEUTRAL GAS. Lehnert, B. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Jul 1969. 15p. Dep. CFSTI (U. S. Sales Only).

A one-dimensional model is considered where a fully ionized plasma is separated from a neutral gas by a homogenous magnetic field directed along the plasma boundary. The plasma and the neutral gas consist of two different types of ions and neutral particles. In a stationary state the outflux of plasma by diffusion across the magnetic field is compensated by an influx of neutrals which are ionized in a partially ionized boundary region. It was found that the ratio between the ion densities in the fully ionized region will in general differ from the density ratio of the two types of neutrals being present in the neutral-gas region. This provides a separation mechanism with applications both to cosmical and laboratory plasmas. (auth) (Sweden)

47233 (NP-18426) LAMINAR COLLISIONFREE ELECTROSTATIC SHOCKS AND SHEATHS. Persson, Hans (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). Apr 1969. 64p. Dep. CFSTI (U. S. Sales Only).

Special Bernstein–Greene–Kruskal solutions of the time-independent, one-dimensional, coupled Vlasov–Poisson equations were studied. The electrostatic potential was assumed to vary monotonically between two different, constant levels, and the ion and electron velocity distributions consistent with this potential were analyzed. The charge neutrality, overall pressure balance, and space charge (internal pressure balance) conditions impose conditions of Mach number type on the collision-free particle distributions. In particular, the Bohm criterion for wall sheaths was analyzed, and was found to apply in all cases when there are not sufficiently many particles of a given species reflected against the potential structure. This structure can be considered as the result of a balance between thermal-like particles, having a negative derivative of the density with respect to the potential energy, and beam-like particles having a positive derivative. Earlier work by Montgomery and Joyce is discussed, and it is shown that, under quite general conditions, the Mach number must exceed unity for small values of the potential. For arbitrary values of the potential, and for trapped electron distributions from a large class of functions, the Bohm criterion implies that the Mach number of the ions behind the shock must exceed a critical value. Another simplified shock model, with equal ion and electron temperatures, and ion reflections against the structure was studied, as well as a couple of simple sheath models. At least in the simplified shock example chosen, laminar solutions exist only for a limited band of Mach numbers, in agreement with fluid shock results. The application of the theory to practical problems and its relationship to nonmonotonic shocks, turbulent shocks, and fluid shocks are discussed, as well as some general questions concerning particle energy and potential differences in plasma. (auth) (Sweden)

47234 (NP-18427) THEORY OF THE LOW PRESSURE POSITIVE COLUMN AT HIGH CURRENT DENSITIES. Torven, Staffan (Kungliga Tekniska Hogskolan, Stockholm (Sweden)). May 1970. 33p. Dep. CFSTI (U. S. Sales Only).

A stationary gas-discharge plasma was investigated at such low pressure that collisions between positive ions and other particles can be neglected. The concepts of plasma approximation and sheath approximation were analyzed and the result was applied to the plane symmetric discharge. When single-stage ionization is considered and the balance between the net fluxes of positive ions and neutrals is taken into account, it was proved that the stationary plasma density is uniquely determined by the velocity and density of the inward gas flux at the plasma boundary, the electron temperature, and the ionization rate. Limits for the maximum obtainable plasma density were calculated for the plane discharge bounded by wall sheaths and, in a simplified model, for a plasma bounded by a space charge double layer. It is suggested that the gas is in a maximally ionized stationary state when limitation of the steady discharge current occurs and nonlinear instabilities (arc chopping, stenotron oscillations) appear in a low-pressure discharge. (auth) (Sweden)

47235 (NYO-3782-4, App.3) WEAK TURBULENT SHOCKS IN MAGNETIZED PLASMAS. Pfirsch, Dieter (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 14p.

From properties of the high beta plasma state.

An expression for the effective collision frequency is derived in terms of $\langle E^2 \rangle / 4\pi n k T_e$. This quantity is shown by similarity considerations to be the same in many different situations. From its value, 0.07, and even from values down to $(m_e/m_i)^2$, it is concluded that present quasi-linear theory and nonlinear wave equa-

tions cannot be used to explain the experimental results. The value 0.07 can be understood as the equipartition between the kinetic energy of the trapped particles and the energy in the electric fields. (auth)

47236 (NYO-3782-4, App.11) ANOMALOUS RESISTIVITY OF A TURBULENT PLASMA. Dum, C. T. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 34p.

From properties of the high beta plasma state.

The conductivity tensor of a turbulent plasma is computed from the coherent response to an external test wave. The enhanced resistivity arises from wave–particle interactions and nonlinear coupling between the test wave and the turbulent spectrum. Nonexpandable effects due to scattering of particles by the turbulent fluctuations and the modification of dielectric properties by turbulence are considered. The conditions under which these effects may become significant, even at low levels of turbulence, are discussed. The possibility of a hydrodynamic description of the turbulent plasma is also discussed, and effective collision frequencies for the resistivity are introduced. The dipole and reactive approximation commonly used in calculations of high-frequency conductivity are re-examined in the context of the new theory. The relation between the resistivity calculation and perturbation theories for a turbulent plasma is shown. An improved kinetic equation for waves is proposed. (auth)

47237 (NYO-3782-4, App.12) TEST WAVES IN A TURBULENT PLASMA. Dum, C. T. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 5p.

From properties of the high beta plasma state.

The conductivity tensor of a turbulent plasma is computed from the coherent response of the plasma to an external test wave. Nonexpandable effects due to scattering of particles and modification of dielectric properties by the turbulent spectrum, which may become important even at low levels of turbulence, are included. (auth)

47238 (NYO-3782-4, App.14) NONLINEAR EXPLOSIVE ION BEAM–PLASMA INTERACTION. Dum, C. T.; Ott, E. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 34p.

From properties of the high beta plasma state.

The explosive three-wave interaction between beam modes and ion–acoustic waves was studied. Coupling coefficients and growth times for the nonlinear interactions are calculated and discussed. One considers both the case of a coherent triplet and that of many interacting waves. The effects of the commonly used assumptions of quasi neutrality and a massless electron fluid on the nonlinear wave dynamics are investigated. The effects of finite geometry are also considered. (auth)

47239 (NYO-3782-4, App.16) RELATIVISTIC MOTION OF A SINGLE PARTICLE UNDERGOING CYCLOTRON RESONANCE IN A MAGNETIC MIRROR TRAP. Faulconer, D. W. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 41p.

From properties of the high beta plasma state.

The relativistic motion of a single particle undergoing cyclotron resonance in a magnetic-mirror trap is studied. The Krylov–Bogolyubov method of averaging is employed to derive equations indicating an upper bound on particle energy. Smallness parameters necessary for the validity of these equations are made explicit. Limitation on particle energy absorption is found for a much broader class of particles than previously known. The relationship of this to experiment is discussed. (auth)

47240 (SINP-TH-67-8) CONDUCTIVITY OF A PLASMA IN A STEADY MAGNETIC FIELD. Pradhan, T.; Dasgupta, B. (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [nd]. 10p. Dep. CFSTI (U. S. Sales Only).

Expressions are derived for the complex conductivity tensor of a homogeneous classical plasma in an external uniform magnetic field, in terms of electric field correlations using the Kubo theory of transport phenomena. The main aim is to bring out explicitly the magnetic field dependence of the conductivity tensor. Exact relations between the conductivity tensor in the presence of the magnetic field and the same tensor in the absence of the magnetic field are obtained. (auth)

47241 HIGH-POWER CONSTRICTED PLASMA DISCHARGE COLUMN. I. THEORETICAL ANALYSIS. Wheeler, C. B. (Imperial Coll. of Science and Tech., London). J. Phys., D (London); 1374-80(Sep 1970).

The equation expressing energy balance between Joule heating and thermal conduction is solved under the assumption that the plasma behaves as a Lorentz gas. This yields two relations for the plasma temperature, one in terms of the electric field E and the column radius R, the other in terms of the current I, the radius R and the ionic charge Z. Elimination of temperature between these relations gives the electrical characteristic $E \propto Z^{\frac{1}{2}} R^{-\frac{1}{2}} I^{\frac{1}{2}}$. The analysis is valid over a range of temperature and density limited at one extreme by radiation losses and at the other extreme by effects of self magnetic field on the transport processes. There is excellent agreement between the temperatures given by this theory and those recently measured spectroscopically for capillary discharges. (auth) (UK)

47242 DIELECTRIC CONSTANT AND BROWNIAN MOVEMENT. ENERGY LOSS OF A PARTICLE IN AN UNSTABLE PLASMA. Soulet, Yves. J. Phys. (Paris); 31: 321-8(Apr 1970). (In French).

The spatio–temporal correlation of two physical quantities is established without any approximation. Then, the case of a medium at equilibrium and described in the ring approximation is studied; the Fokker–Planck diffusion coefficient of the equation describing the evolution of an inhomogeneous distribution of particles weakly coupled with such a medium is expressed with the help of the spatio–temporal density correlation in the long-time approximation. In the description of the Markoian evolution of a weakly inhomogeneous distribution and the non-Markovian evolution of a strongly inhomogeneous distribution, the dielectric constant was shown to play a fundamental part. The energy loss of a heavy particle through an unstable plasma was studied and the accelerating role of the medium was pointed out. (tr-auth) (France)

47243 ELECTROMAGNETIC RADIATION FROM ANISOTROPIC TURBULENT PLASMA. Ichimaru, Setsuo (Univ. of Illinois, Urbana); Starr, Stuart H. Phys. Rev., A; 2: 821-5 (Sep 1970).

The radiation spectrum from an anisotropic turbulent plasma is found to have a definite relationship to the turbulence spectrum. The intensity of such a radiation is estimated to be significantly greater than that expected from a scattering experiment. (auth)

47244 QUANTUM-STATISTICAL THEORY OF A MULTICOMPONENT FULLY IONIZED GAS. Rama Rao, I. (Stanford Univ., Calif.); Smith, Charles Ray. Phys. Rev., A; 2: 843-54 (Sep 1970).

The quantum-statistical theory of a nonrelativistic fully ionized gas in thermal equilibrium is developed, using the well-known linked-cluster expansion of the grand potential. A systematic analysis of the self-energy structures leads to a master-graph formulation of quantum statistics. This provides a much simpler derivation and improved version, with important differences, of the earlier work of Mohling and Grandy. In particular, the analysis of the photon self-energy structures is now entirely different. The present formulation includes the technique of adding and subtracting in the Hamiltonian a single-particle operator, and the relation of this technique to the Λ-transformation method of Mohling, RamaRao, and Shea is indicated. As an application of the general theory, the lowest-order calculations of the photon self-energy and photon momentum distribution are presented. The result for the photon momentum distribution is different from that of Hwang and Grandy, and the reason for the difference is given. Finally, explicit connections between the master-graph line factors and Green's functions are outlined, and the consequences of such a connection are indicated. (auth)

47245 TRANSITION RADIATION IN A PERIODICALLY STRATIFIED PLASMA. Casey, K. F. (Air Force Inst. of Tech., Wright-Patterson Air Force Base, Ohio); Yeh, C. Phys. Rev., A; 2: 810-18(Sep 1970).

The solution to the problem of determining the transition radiation emitted when a charged particle moves uniformly in a periodically stratified cold, isotropic plasma is obtained. The electromagnetic field may be expressed in terms of an infinite number of normal modes. The conditions under which some of these modes are radiative are discussed, and expressions for the field components and the energy spectral density are obtained. It is found that radiation may be emitted for arbitrarily small particle velocities and that the strongest emission takes place in a frequency band just above the average plasma frequency. Numerical results are presented to illustrate the behavior of the spectra of the various radiative modes as the frequency and plasma parameters are varied. (auth)

47246 PERTURBATIVE THEORY OF SELF-DIFFUSION IN CLASSICAL MANY-PARTICLE SYSTEMS. I. VELOCITY AUTOCORRELATION FUNCTION. Corngold, Noel (California Inst. of Tech., Pasadena); Duderstadt, James J. Phys. Rev., A; 2: 836-43(Sep 1970).

To investigate the diffusive motion of a test particle in a classical many-body system, the projection-operator formalism of Zwanzig was applied to the calculation of the velocity autocorrelation function. The memory kernel in this formalism is investigated by using a perturbation expansion in a parameter char-

acteristic of the time scale of correlations in the system. General studies of the asymptotic time behavior of the correlation function are given, as well as several explicit calculations for modeled interparticle potentials. (auth)

47247 COVARIANT FORMULATION OF RELATIVISTIC QUANTUM STATISTICAL MECHANICS. II. THE LIOUVILLE EQUATIONS FOR A RELATIVISTIC QUANTUM PLASMA. Balescu, R. (Univ. Libre, Brussels. Univ. of Texas, Austin). Acta Phys. Austr.; 29: 313-28(1969).

The equation of evolution for the Wigner function describing a quantum plasma is derived in the Fourier representation. Liouville equations for the spatial translations and the Lorentz transformations of the Wigner function are also given explicitly. In this formulation the algebraic structure of the quantum theory is exactly the same as for the classical theory. The only difference between the two theories lies in the realization of the abstract symbols. Hence, most of the general results derived previously for classical systems go over directly into the quantum theory. (auth)

47248 ION MOTION IN PLASMA LINE BROADENING. Dufty, James W. (Univ. of Florida, Gainesville). Phys. Rev., A; 2: 534-41(Aug 1970).

A recently developed method to study ion-motion effects on plasma line broadening in the dipole approximation is extended to the general interaction. Coupling-constant and binary-collision expansions are obtained for the "width and shift" operator. This operator is investigated for a model system to show the limits of the static-ion approximation. (auth)

47249 NONRELATIVISTIC ELECTRON BREMSSTRAHLUNG IN A STRONGLY MAGNETIZED PLASMA . Canuto, V.; Chiu, H. Y. (Goddard Space Flight Center, New York). Phys. Rev., A; 2: 518-25(Aug 1970).

The emission of bremsstrahlung radiation of nonrelativistic electrons in Landau levels in a dense plasma is calculated. It is found that the radiation rate is inversely proportional to the electron momentum, which is characteristic of one-dimensional gases. (auth)

47250 THEORY OF RESISTIVITY IN COLLISIONLESS PLASMA. Dupree, T. H. (International Centre for Theoretical Physics, Trieste, Italy). Contract AT(30-1)-3980. Phys. Rev. Lett.; 25: 789-92(21 Sep 1970).

An electron drift driven by an applied constant electric field causes an ion-acoustic instability. A steady state is proposed in which ballistic clumps of plasma behave like dressed test particles and collisionally scatter each other. The applied field is balanced by the dynamical friction force on the clumps. The resulting conductivity is $\sigma \approx 10\omega_{pe}/k\lambda_D$. (auth)

47251 ELECTRICAL CONDUCTIVITY OF A PARTIALLY IONIZED GAS IN PRESENCE OF A MAGNETIC FIELD. Antoniazzi, V. (Consiglio Tecnico-Scientifico, Rome); Molinari, V. Alta Freq.; 39: 411-16(May 1970).

The Frost mixture rules for the calculation of the electrical conductivity of a partially ionized gas in absence of a magnetic field, are extended to the case when a magnetic field is applied. The cases of three component (electrons, a single ion species and a single neutral species) and four component gases (electrons, a single ion species and a double neutral species) are considered. In the first case the tensor components of the electrical conductivity are expressed in terms of confluent hypergeometric functions. In the second case a comparison with the approximate mean-free-path formulas is made. (auth)

47252 LINEAR MECHANISM FOR THERMAL ENERGY TRANSPORT IN CURRENT-CARRYING PLASMAS. Coppi, B. (International Centre for Theoretical Physics, Trieste, Italy). Phys. Rev. Lett.; 25: 851-3(28 Sep 1970).

Collisionless modes extracting electron thermal energy and convecting it radially are considered as a possible explanation of the electron thermal energy radial transport, larger than the one predicted by the proper collisional theory, in confined high-temperature plasmas carrying a current along the magnetic field. (auth)

47253 MICROWAVE EMISSION FROM A MAXWELLIAN MAGNETOPLASMA. Shimomura, Noboru (Osaka Kyoiku Univ.). J. Phys. Soc. Jap.; 29: 759-64(Sep 1970).

The microwave emission from a Maxwellian magnetoplasma in a uniform magnetic field is studied near electron cyclotron harmonic frequencies. Following the dressed test-particle approach, the energy lost by one test electron is calculated and, from this, the total emission is obtained by integrating over all electrons weighted by their velocity distribution. The dispersion relation for the electrostatic wave propagating in the direction nearly perpendicular to a magnetic field has, in general, two solutions, comprising a slow and a fast electrostatic wave. It is found on the CMA diagram that the emission by slow electrons whose velocity is nearly the thermal velocity has a peak near lower harmonic side and the shift of the peak from the harmonic scarcely depends on electron density, while the emission by fast superthermal electrons has no peak and the position of the emission by electrons with the specified high velocity moves from the lower harmonic side to the higher side with increase of the density. (auth)

47254 TRANSPORT COEFFICIENTS OF N_2 PLASMA UP TO 13,000°K. Plantikow, U. (Technische Hochschule, Munich). Z. Phys.; 237: 388-402(1970). (In German).

In a cascade arc chamber a stationary nitrogen plasma was produced at a pressure of 1 atm. In this plasma the integral material function, the E-I characteristic, could be measured very exactly. From this characteristic the transport coefficients of nitrogen (the electrical conductivity σ and the heat flux potential S) were evaluated in dependence on the arc radius r with the arc current I as parameter. With these, and by the help of the temperature distributions measured by Schade, the transport coefficients dependent on temperature T only were obtained. The thermal conductivity κ was found by differentiation of the S(T) curve. The evaluation was only performed up to 13,000°K because the radiation has been neglected in the calculation that is no longer allowed above 13,000°K. At low currents the influence of the high field strength causes non-LTE increasing with rising field strength. This effect of non-LTE could be regarded qualitatively and quantitatively. As a result the thermal and electrical conductivity of N_2 from 5,000 to 13,000°K was obtained. The consistence with former measurements and with theoretical calculations is very satisfying. (auth)

47255 PRACTICAL DIFFERENCE SCHEME FOR FOKKER-PLANCK EQUATIONS. Chang, J. S.; Cooper, G. (Univ. of California, Livermore). J. Comput. Phys.; 6: 1-16(Aug 1970).

A practical finite difference scheme for initial value problems of Fokker-Planck equations is studied. In addition to satisfying the conditions of convergence and unconditional stability, this scheme provides numerical solutions which preserve some of the more important intrinsic properties of the original partial differential equation. In particular, the solutions are non-negative, particle conserving in the absence of external sources or sinks, and exact representations of the analytic solution upon equilibration. Furthermore, coupled with variable mesh size, this scheme actually significantly reduces the number of mesh points required with no loss of accuracy. (auth)

47256 COMPTON INTERACTION OF A PHOTON GAS WITH A PLASMA. Woodward, Paul (Univ. of California, Livermore). Phys. Rev., D; 1: 2731-4(15 May 1970).

The rate of energy transfer due to Compton collisions from a photon gas to a Maxwell electron gas is calculated to fourth order in the expansion parameters kT_e/mc^2 and kT_R/mc^2. The photon distribution is taken to be Planckian at a temperature T_R not equal to the electron temperature T_e. It is found that the nonrelativistic expression is accurate only for $kT_R \leq 2.5$ keV and $kT_e \leq 20$ keV, while the fourth-order expression is accurate for $kT_R \leq 10$ keV and $kT_e \leq 80$ keV. (auth)

47257 ENERGY-CONSERVING NUMERICAL APPROXIMATIONS FOR VLASOV PLASMAS. Lewis, H. Ralph (Los Alamos Scientific Lab., N. Mex.). J. Comput. Phys.; 6: 136-41(Aug 1970).

A unified and general method is presented for deriving numerical approximation schemes within the framework of the trajectory approach. The physical problem is described and an outline is given for applying Hamilton's principle to the derivation of approximation schemes. Then the energy theorem is discussed. Finally, an example appropriate to numerical simulation by a finite number of particles is presented. (M.O.W.)

47258 KINETIC EQUATION FOR THE TEST-PARTICLE PROPAGATOR. Tataru, P. I. Stud. Univ. Babes-Bolyai, Ser. Phys.; 15: 65-70(1970).

The test particle formalism is used to obtain the kinetic equation for the test-particle propagator. The test-particle equation is then written as a diffusion equation and the conditions of existence and uniqueness of the solution are described. (M.O.W.)

47259 HYPERFREQUENCY PARAMETRIC AMPLIFICATION THROUGH BEAM-PLASMA INTERACTIONS. Pham-Tu-Manh (Paris Univ., Orsay, France). J. Phys. (Paris); 31: 329-37 (Apr 1970). (In French).

A theoretical study concerning uhf parametric amplification performed in a beam-plasma system is reported. Because of the

nonlinear properties of such a medium, the energy available at the pump frequency F_p can be converted into energy at the frequency F_s of the signal to be amplified. The theoretical model is that of a traveling-wave parametric amplifier, the pump wave being propagated by the beam, the signal and idler (frequency $F_i = F_p - F_s$) waves by the plasma. A perturbation method is used to calculate the growth rate of the signal wave F_s, and the results show that very high gains can be expected from such an amplifier. (tr-auth) (France)

Production

47260 (CEA-N-1337) ENERGY TRANSFER IN INTERACTIONS BETWEEN A LASER BEAM AND SOLID DEUTERIUM. Reuse, J. (Commissariat a l'Energie Atomique, Limeil-Brevannes (France). Centre d'Etudes). Jun 1970. 31p. (In French). Dep. CFSTI (U. S. Sales Only).

The energy transfer in interactions between a laser beam and solid deuterium is investigated theoretically. The absorption of the laser radiation, the re-emitted radiative energy, the electron conduction and the preheating front are considered. (tr-auth) (France)

47261 PULSED ARCS IN ARGON AND HELIUM AT MICROWAVE FREQUENCIES. Borovik, E. S.; Petrenko, V. I.; Mitin, R. V.; Kantsedal, V. P.; Knyazev, Yu. R. (Physical-Technical Inst., Kharkov). Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1063-9 (Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1416-24(Aug 1969).

Results are described of a study of superhigh-pressure pulsed arcs in argon and helium (at pressures of up to 8×10^7 N/m^2 in argon and up to 4×10^7 N/m^2 in helium) at currents of up to 100 kA with pulse lengths of ~1.3 msec. An essentially completely ionized plasma forms during the discharge, with a temperature of 4 to 8×10^4 °K and a charged-particle density of (4 to 7) $\times 10^{19}$ cm^{-3}. Diffusion of heat from the central regions to the surface is shown to be greatly hindered by the strongly trapped radiation. Microphotographs of the surface radiation spectra and photographs of the pulsed discharges are shown. (auth)

47262 BREAKDOWN WAVE, SHOCK WAVE, AND RADIATION WAVE IN LASER-CREATED PLASMAS. Veyrie, P.; Floux, F. (CEA, Paris). AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1405-11(Aug 1970).

The various phenomena occurring during the growth of laser-generated plasmas are both theoretically and experimentally presented. The experimental results obtained with short and long laser pulses and short and long focal lengths are described. Their interpretation is based on three different models, depending on experimental condition. The existence of an ionization threshold implies the possibility of a breakdown wave, especially in the case of short pulses, or the formation of a radiation-supported shock wave. For experiment with high-density targets, the opacity may be so high that the thermal radiation conductivity is the principal reason for propagation of ionization and heating. (auth)

Stability

47263 (LA-4487) ELECTRON CYCLOTRON DRIFT INSTABILITY. Forslund, D. W.; Morse, R. L.; Nielson, C. W. (Los Alamos Scientific Lab., N. Mex.). Jul 1970. Contract W-7405-eng-36. 10p. Dep. CFSTI.

Analytic and numerical calculations demonstrate a plasma instability driven by currents flowing normal to a magnetic field. (auth)

47264 (NYO-3782-4, App.6) STABILITY OF NONUNIFORM PLASMA. Auer, P. L. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 12p.

From properties of the high beta plasma state.

A study was made using a classical sheath geometry of a plane interface between plasma and confining magnetic field that is axial and spatially varying in one direction. Equilibrium and perturbation conditions are discussed. Dispersion relations are derived. (M.O.W.)

47265 (NYO-3782-4, App.7) TOROIDAL EQUILIBRIA OF A RELATIVISTIC ELECTRON PLASMA. Rostoker, N.; Hieronymus, J. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 36p.

From properties of the high beta plasma state.

A self-consistent equilibrium for a relativistic electron plasma is determined in toroidal geometry. An externally produced toroidal magnetic field is assumed, and the walls of the torus are treated as perfect conductors. (auth)

47266 (NYO-3782-4, App.8) NONLINEAR STABILIZATION OF HIGH FREQUENCY INSTABILITIES IN A MAGNETIC FIELD. Dum, C. T. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 67p.

From properties of the high beta plasma state.

It is shown that the broadening of wave–particle resonances by the random motion of particles in a turbulent electric field may determine the saturation level of a variety of high-frequency instabilities. Secular changes of the guiding-center positions, cyclotron radii, and phase angles give rise to resonance broadening and diffusion similar to that produced by collisional scattering. The field-dependent broadening is expressed in terms of resonance functions that replace the familiar resonant denominators of the linear theory. Resonance functions are derived in a simple manner from the solution of a Brownian motion problem, leading to an expression in terms of diffusion coefficients. The close resemblance of the theory to quasi-linear theory and the linear theory including collisions allows one to start from a linear stability analysis and then assess the importance of nonlinear effects. This method is illustrated by the determination of the saturation level of cyclotron instabilities from the condition of vanishing nonlinear growth rate. (auth)

47267 (NYO-3782-4, App.13) NONLINEAR BEAM–PLASMA INTERACTION AND STOCHASTIC ACCELERATION. Dum, C. T.; Sudan, R. N. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 35p.

From properties of the high beta plasma state.

The development of an electron beam–plasma instability beyond the stage described by quasi-linear theory was investigated by means of kinetic equations for waves and particles that include the effects of spontaneous emission and scattering of waves. Characteristic times were calculated for the formation of a high-energy tail, which at late times may extend significantly beyond the original beam velocity. Reasonable agreement is obtained with experiments. (auth)

47268 (ORO-3458-9) ANOMALOUS DIFFUSION AND THERMALIZATION OF TURBULENT PLASMAS. Progress Report No. 4. (Texas Univ., Austin. Dept. of Physics). Jul 1970. Contract AT(40-1)-3458. 12p. Dep. CFSTI.

An extensive study was made on the magnetohydrodynamic stability of Takamak plasmas. The different modes are briefly described. Trapped-particle effects and other instabilities are also discussed. (M.O.W.)

47269 (UCRL-Trans-10482) ION CYCLOTRON INSTABILITY IN A NONUNIFORM MAGNETIC FIELD. Timofeev, A. V. Translated for Univ. of California Lawrence Radiation Lab., Livermore, from report IAE-1939. 69p. Dep. CFSTI.

Nonuniformity of the magnetic field disturbs the resonance between cyclotron oscillations and the revolving of charged particles around the Larmor circumference. This decreases the increment of unstable natural oscillations of plasma having a frequency close to the ion cyclotron frequency. The stabilizing effect is particularly pronounced with a high electron temperature. (auth)

47270 VELOCITY-SPACE PLASMA INSTABILITIES DUE TO SELF-INTERACTION OF A SINGLE SPECIES. Grewal, Mahesh S. (Wichita State Univ., Kan.). Phys. Rev., A; 2: 787-92(15 Sep 1970).

Electrostatic instabilities are studied in an infinite uniform homogeneous plasma imbedded in a uniform magnetic field that is driven by the anisotropy of the velocity distribution function of only one of the species that comprise the plasma. Specifically, the discussion concerns three instabilities that arise when the temperature of the driving species perpendicular to the applied magnetic field is different from its temperature parallel to the magnetic field, and the velocity distribution of the driving species perpendicular to the field is (a) a Maxwellian, (b) a loss-cone type, and (c) a δ function. Results are presented for two cases when the driving species are (a) the ions and (b) the electrons. Results show that these instabilities appear only when the plasma frequency of the driving species becomes comparable to or larger than its cyclotron frequency. (auth)

47271 STABILITY OF A PLASMA CYLINDER IN THE FIELD OF A TRAVELING MAGNETIC WAVE TAKING HALL CURRENTS INTO ACCOUNT. Starkova, V. N. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1055-8(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1405-10(Aug 1969).

Using a magnetohydrodynamic model, the stability of a plasma cylinder contained by the field of a traveling magnetic wave is investigated. A constant component of Hall current is excited in the plasma. It is assumed that the Hall current does not distort the distribution of the primary rf field, which is considered to

exist only on the plasma surface. Slow perturbations of the plasma filament are examined. (auth)

47272 NONLINEAR COLLISION-INDUCED INSTABILITY. Stenflo, L. (Inst. of Physics, Uppsala). Z. Phys.; 238: 184-8 (1970).

Large-amplitude waves in a homogeneous plasma are studied in the vicinity of a marginally stable state. The theory predicts a collision-induced instability phenomenon which may be of experimental interest in semiconductor physics. (auth)

Thermonuclear Processes

Refer also to abstract 47060.

47273 STABILIZED LEVITATION OF MAGNETIC ELEMENTS. North, George G. (to United States Atomic Energy Commission). U. S. Patent 3,512,852. 19 May 1970. Filed 7 Mar 1969.

A system is described for stabilizing a magnetic element, such as a magnetized disc or conductive ring that is levitated in a magnetic field. The magnetic element is positioned with its magnetic field in opposition to a vertically oriented magnetic levitation field such that the fields interact to freely support the element against the forces of gravity. Any tendency of the element to slip laterally from its stable support position to unstable support positions is continuously sensed and responsively compensated by the generation of a magnetic compensating field which is effective to restore the element to its stable position. (M.O.W.)

47274 LASER AND THERMONUCLEAR FUSION. Witkowski, S. (Institut fuer Plasmaphysik, Garching, Ger.). Naturwissenschaften; 57: 211-16(May 1970). (In German).

Plasma production through giant lasers is surveyed with respect to gases and solids. Models for plasma production are analyzed first generally and then specifically for a one-dimensional plane gasdynamic model. Experimental studies of the gasdynamic model are reviewed. Possibility of nuclear fusion through lasers is treated from a theoretical standpoint. Although fusion reactors based on lasers are not feasible at the present time, laser-produced plasmas contribute significantly to basic research concerning thermonuclear fusion; because a previously inaccessible range of temperature and density is opened, plasma–light interaction can be studied in the region of nonlinear effects, high purity plasma can be achieved, and application as short-term neutron sources for various diagnostic purposes is a possibility. (H.B.G.)

47275 TEST PLASMA IN THE W IIa WENDELSTEIN STELLARATOR. Grieger, G. (Institut fuer Plasmaphysik, Garching, Ger.). Naturwissenschaften; 57: 216-22(May 1970). (In German).

Development of the stellarator is discussed in general and experimental findings are reported for the W IIa in Wendelstein. The plasma source consists of a tungsten sphere, 3 mm in diameter that is suspended exactly in the magnetic axis. This sphere is heated to a stationary state of 2300°K by means of a CO_2 laser and serves as target for a collimated barium atomic beam. The barium atoms are ionized by the tungsten sphere and, together with thermally emitted electrons, form a well-defined plasma source. Experimental findings are presented in nine diagrams. After conclusion of the experiments, design of a larger stellarator with higher plasma temperature and increased magnetic field strength is projected. (H.B.G.)

47276 X-RAY AND NEUTRON EMISSIONS OF A FOCUSING NONCYLINDRICAL DISCHARGE. Patou, Claude (Centre d'Etudes de Limeil, Villeneuve-Saint-Georges, France). J. Phys. (Paris); 31: 339-50(Apr 1970). (In French).

X-ray and neutron emissions from a plasma generated by an electrical discharge between two coaxial electrodes were studied. The electron temperature was measured from x rays in two ways: first by the absorbing-foil technique in which the energy transmitted through various material foils of different thickness was measured; and also by the comparison of the energy emitted at two different wavelengths with two crystal monochromators. The time-resolved electron temperature and some simple hypotheses led to a correlation between x-ray and neutron emissions. The neutron energy spectrum anisotropy and the neutron flux anisotropy were both studied. It seems now certain that an m = 0 instability cannot explain the origin of the neutrons. On the contrary, the thermal moving plasma gives accounts for most experimental results. (tr-auth) (France)

Wave Phenomena

Refer also to abstracts 47080 and 47238.

47277 (NYO-3782-4, App.1) NON-ADIABATIC TREATMENT OF FINITE TEMPERATURE EFFECTS IN A MAGNETOSONIC DISTURBANCE. Kinsinger, R. E.; Auer, P. L. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 25p.

From properties of the high beta plasma state.

In a cold plasma, finite-amplitude magnetosonic disturbances lead to the familiar steady-state solitary pulse of Adlam and Allen. The effect of finite plasma pressure and ion gyro radius on these disturbances is considered. Earlier limitations imposed by adiabatic considerations are removed. The weakly nonlinear regime was studied, and it was found that the inclusion of finite temperature leads to a singular perturbation scheme. The nature of pulse distortions due to these effects is discussed both analytically and numerically. (auth)

47278 (NYO-3782-4, App.2) ION GYRORADIUS EFFECT IN THE SOLITARY PULSE. Auer, P. L. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 14p.

From properties of the high beta plasma state.

The steady-state Vlasov equation was solved for motion transverse to a steady but nonuniform axial magnetic field. An analysis using the rectilinear approximation is given along with the effects of finite gyroradii and helical orbits. (M.O.W.)

47279 (NYO-3782-4, App.15) NONLINEAR LANDAU DAMPING AND BEAT WAVE TRAPPING. Ott, E.; Dum, C. T (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 9p.

From properties of the high beta plasma state.

The nonlinear interaction of two coherent waves with particles of velocity near $(\omega_1-\omega_2)/(k_1-k_2)$ is investigated. For times short compared to the trapping time in the beat wave, one finds the usual nonlinear Landau damping result, derived previously for the incoherent (turbulent) case. For two coherent waves, however, trapping severely limits the validity of this result. (auth)

47280 INTERACTION OF A RADIO-FREQUENCY ELECTROMAGNETIC FIELD ON A MOVING PLASMA. Paris, R. B. (Manchester Univ., Eng.); Vermeulen, P. J. J. Brit. Interplanet. Soc.; 23: 189-210(1970).

The interaction of a lightly ionized argon plasma, produced by a dc arc discharge at atmospheric pressure and at a mean temperature of about 7000°K, flowing through an electromagnetic field oscillating at radio frequencies (1-10 MHz) is studied on a magnetogasdynamical model. Coupling between the plasma and the electromagnetic field was found to occur and theoretical temperature distributions along the length of the plasma flow distinctly exhibited the skin effect, whereby most of the power from the electromagnetic field is concentrated near the plasma surface. The maximum temperature attained and the shape of the gaseous radio frequency discharge plume in the theoretical model agree well with previous experimental observations. (auth)

47281 DETERMINATION OF THE TURBULENCE LEVEL IN A COLLISIONLESS MAGNETOSONIC SHOCK WAVE BY MEASURING THE STARK BROADENING OF THE BALMER Hβ LINE. Zagorodnikov, S. P.; Smolkin, G. E.; Striganova, E. A.; Sholin, G. V. JETP Lett. (USSR) (Engl. Transl.); 11: 323-6(20 May 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 475-8 (20 May 1970).

A solution is developed to determine the presence of turbulence in a shock wave, to measure its level, and to determine the nature of the disturbance. Previously, front thickness of the collisionless magnetosonic shock wave propagating across a magnetic field and the jump of the electron temperature on the front were measured. The effective collision frequency required to explain these results is $\nu_{eff} \gtrsim 2 \times 10^9$ sec^{-1}. This exceeds the Coulomb frequency by two orders of magnitude and can occur only if turbulent electrostatic oscillations develop in the plasma. According to theory, several types of electrostatic plasma instabilities can occur in the transition zone of the shock wave. The turbulence level can exceed the equilibrium level by several orders of magnitude. At such levels and at characteristic plasma parameters, the electric field intensity in the oscillations can exceed the interparticle field by one order of magnitude. It is useful to use the Stark splitting of hydrogen spectral lines for the measurement of the turbulence level on the front of a magnetosonic shock wave. Results are presented of the measurement of the Hβ line profile in a nonequilibrium plasma produced on the front and behind the front of a collisionless magnetosonic shock wave. The measurements were made with the UV-2 apparatus by the method of high-speed electron-optical spectrochronography. (J.C.W.)

47282 RESONANT ABSORPTION OF LOW-FREQUENCY ELECTROSTATIC WAVE ENERGY IN A PLASMA CONTAINED

IN AN AXIALLY NONUNIFORM MAGNETIC FIELD. Miayke, Shoji; Sato, Teruyuki; Takayama, Kazuo (Nagoya Univ., Japan). J. Phys. Soc. Jap.; 29: 769-75(Sep 1970).

Resonant power absorption of electrostatic ion cyclotron wave energy in a nonuniform magnetic field is calculated following Kuckes' model. The calculation explains the experimental evidence of the large suppression effect on the line cusp loss by the resonant absorption of this wave. (auth)

47283 EXCITATION OF ELECTRON PLASMA OSCILLATION BY ION-ACOUSTIC WAVES. Amagishi, Yoshimitsu (Fukushima Tech. Coll., Iwaki City, Japan). J. Phys. Soc. Jap.; 29: 764-8(Sep 1970).

Electron plasma oscillations were generated by application of one characteristic low-frequency fields to a mesh anode. Conditions for the excitation of electron plasma oscillations are that the positive column is bounded by the ion sheath and the voltage of the applied signal is above a certain value. These excited oscillations, which are of the Looney-Brown type, are possible only on a certain phase of the low-frequency fields. The low frequencies associated with the excitation coincide with those of radial ion-acoustic wave modes. Therefore, only the external frequency that satisfies the boundary condition determined by the argument of the Bessel function, can participate in the excitation of electron plasma oscillation. (auth)

47284 NONLINEAR WAVE INTERACTIONS IN A MAGNETOACTIVE PLASMA. Weyl, Guy Michael. Los Angeles; Univ. of California (1969). 118p. University Microfilms Order No. 70-8222.

Thesis.

The nonlinear interactions of two electromagnetic waves resulting in the excitation of electrostatic oscillations of a homogeneous plasma in a strong magnetic field are studied. Starting from the Vlasov equation for electrons, and neglecting ion motions, a general expression for the second-order density perturbation of the plasma in the presence of two first-order electromagnetic waves is derived. The parametric excitation of drift waves in an inhomogeneous resistive plasma is derived from the fluid equations. In the particular case studied, the plasma is pumped by a drift wave at ω_0 and responds at a frequency $\omega_1 = \frac{1}{2}\omega_0$. Plane geometry is assumed in the derivation but periodic boundary conditions in z (direction of the uniform magnetic field) and in y (azimuthal direction) are assumed, to simulate experimental conditions with cylindrical or toroidal geometry. The resulting discrete spectrum of drift waves is assumed stabilized by end plate effects (for lower-frequency modes) or by ion-ion collisions (at higher frequencies). The threshold amplitude for parametric excitation is calculated and the enhancement of fluctuations below threshold leading to enhanced particle diffusion toward regions of decreasing density is calculated, and a comparison with experiment is made. The possibility of measuring the enhanced fluctuation spectrum by microwave scattering experiments is also studied. (Diss. Abstr. Int., B)

47285 SOME INVESTIGATIONS OF WAVE-PARTICLE INTERACTIONS. Kruer, William L. Princeton, N. J.; Princeton Univ. (1969). 138p. University Microfilms Order No. 70-8374.

Thesis.

Special attention is given to higher-order effects such as wave scattering by fast particles and to nonexpandable effects such as the broadening of the wave-particle resonance and particle trapping by large amplitude waves. (Diss. Abstr. Int., B) (TSS)

47286 HIGHER-ORDER RESONANCES IN A PLASMA AND PARAMETRIC EXCITATION OF A PLASMA. Chen, Chiu-shan. San Diego, Calif.; Univ. of California (1969). 96p. University Microfilms Order No. 70-8646.

Thesis.

Both magnetized and unmagnetized electron plasmas, with a constant ion background, driven by a two-grid source (with both "adiabatic" switching and finite pulse) are investigated. It is shown by using perturbation theory analysis that the plasma responds resonantly when the source frequency is ω_p/n (unmagnetized plasma), $2\Omega/n$ or ω_H/n (magnetized plasma) for a continuous source where ω_p, Ω and ω_H are the plasma, the cyclotron and the upper hybrid frequencies and n is an integer. It is also shown that as may be expected the finite pulse length does not alter or add to the resonances obtained. It is further shown in a magnetized plasma that as a resonant frequency is approached from below, the asymptotic solution represents a wave whose group and phase velocities are in opposite directions, whereas, if it is approached from above, the solution is a wave with group and phase velocities in the same direction. These fractional resonances are tentatively identified as those seen in Alouette II topside sounder data. A nonlinear mechanism is proposed to explain the observability of these resonances. The parametric effect of an applied space uniform oscillating electric field on both unmagnetized and magnetized plasmas is also investigated. By using a perturbation method of multitime scales one can show that parametric excitation of transverse waves propagating obliquely to the applied field in an unmagnetized plasma is possible. The growth rate of the excited waves reaches a maximum for transverse propagation. Ion motion does not change the character of the parametric excitation except by reducing the growth rate. In a magnetized plasma it is shown that excitation of a pair of waves is possible where one is a Langmuir wave, propagating along the magnetic field and the other is a circularly polarized transverse wave propagating in the opposite direction. (Diss. Abstr. Int., B)

47287 PROPAGATION AND DAMPING OF ELECTROSTATIC ION WAVES IN A PLASMA SUPPORTED BY A UNIFORM MAGNETIC FIELD. Hirose, Akira. Knoxville; Tenn., Univ. of Tennessee (1969). 67p. University Microfilms Order No. 70-7574.

Thesis.

Electrostatic ion waves in a nonisothermal ($T_e \gg T_i$) plasma supported by a uniform magnetic field are investigated experimentally and, in part, theoretically. Two major topics are included: Landau damping of ion acoustic waves due to both electrons and contaminant ions and dispersion measurements of electrostatic ion waves propagating at arbitrary angles with respect to the magnetic field. Experiments were performed in a xenon plasma produced by a newly designed plasma source. (Disser. Abstr. Int., B) (TSS)

47288 STRUCTURE OF TWO-STREAM OSCILLATIONS EXCITED BY AN ELECTRON BEAM IN A PLASMA. Yaremenko, Yu. G.; Deev, V. M.; Eremin, S. M.; Kharchenko, I. F. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1158-60(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1541-5(Aug 1969).

An experimental study was made of the temporal and spatial structure of the plasma oscillations that are excited by an electron beam in a plasma in the range 500 to 1500 MHz. The randomness and stationarity of the oscillations have been investigated. The oscillations were observed directly and by correlation analysis. Observations have been made of the time variation of the instantaneous spectra during an rf pulse. The cross-correlation function for the rf signals picked up from two probes at different points in the plasma column was calculated for the purpose of investigating the spatial structure and determining the correlation length. The determination of the structure of the oscillations was important in clarifying the mechanism of excitation. (auth)

47289 ION SOUND TURBULENCE IN A COLLISIONLESS SHOCK WAVE. Biskamp, D. (European Space Research Inst., Frascati, Italy). J. Geophys. Res.; 75: 4659-65(1 Sep 1970).

The dispersion relation for ion-acoustic waves that can propagate in a plasma, with the geometry corresponding to a collisionless perpendicular shock wave, is investigated. It is found that for $(k_{\|}/k_{\perp}) > (m_e/m_i)^{\frac{1}{2}}$ these modes behave as ion sound waves in an unmagnetized plasma. In the presence of ion sound turbulence, electrons diffuse rapidly. As a consequence, the distribution function becomes square-shaped with spherical symmetry, and the electrons are heated. The heating rate is small, however, over a typical shock thickness. By comparing the results with measurements of the electron distribution function at the earth's bow shock, qualitative agreement regards the shape of f, whereas the observed jump of the electron temperature seems to be due essentially to adiabatic heating. (auth)

47290 FREQUENCY EFFECTS OF ELECTROMAGNETIC SCATTERING FROM UNDERDENSE TURBULENT PLASMAS. Schapker, Richard L. (Avco Everett Research Lab., Everett, Mass.). Contract F04701-69-C-0122. AIAA (Amer. Inst. Aeronaut. Astronaut.) J.; 8: 1582-90(Sep 1970).

Generalized relations are presented for the first and second moments of the scattered power spectrum function, for underdense turbulent plasmas, in terms of the spatial distribution of electron density and velocity fluctuations and of mean velocity. The scattering model is based on the far-field and first-Born approximations; retarded potential effects are neglected through use of a time-smoothed autocorrelation function of the received electric field signal. A form of the space-time autocorrelation function for electron density fluctuations is derived that accounts for unequal velocity fluctuation components and electron molecular diffusivity to first order. Specific application of the theory is made to axisymmetric near-wake flows, for which the molecular diffusivity effect on the spectrum function is negligible. In particular, the case of backscattering at small aspect angles is considered. Radial profiles of rms electron density and longitudinal velocity fluctuations, as well as mean velocity, are used that are based on available experimental data. Under the assumption that the spatial

electron density spectrum function is constant throughout the scattering volume, relatively simple analytic expressions are arrived at for the first and second moments of the scattered power spectrum function. Numerical results are presented for these moments, interpreted as range rate (or Doppler mean wake velocity) and velocity standard deviation (or Doppler velocity spread). For conditions supported by available data, it is found that, to a first approximation, (1) range rate is equal to the difference between body velocity and mean wake velocity averaged over a wake cross section, U_a, and (2) velocity standard deviation is equal to the difference between the wake front velocity and U_a. (auth)

47291 WATER BAG: MODEL IN PHASE SPACE FOR STUDYING COLLISIONLESS PLASMAS. Bertrand, Pierre; Feix, Marc R. (Nancy Univ.). J. Phys. (Paris); 31: 451-7(May-Jun 1970). (In French)

A useful model in plasma oscillation problems was obtained by considering a distribution function $f(\chi, \nu, t = 0)$ equal to a constant A inside a region of phase space limited by two curves $V \pm (\chi, t)$ and equal to 0 elsewhere. The plasma was therefore considered as being an incompressible, homogeneous fluid in phase space and the evolution of the two boundaries only had to be studied. A formal analogy was shown between this model and a hydrodynamic model. The nonlinear plasma oscillations were studied by introducing a stream function and Lagrangian variables. Initial situations in which one or two modes are excited were considered. The harmonics and the wave–wave interactions were studied. For long wavelengths and small nonlinearities, the complete solution obtained revealed interesting interactions between thermal and nonlinear terms, especially the frequency drift of the nonlinear plasma oscillation. A computer simulation of this model was performed, and the numerical results were shown to be in good agreement with the theory. (tr-auth) (France)

Shielding

Refer also to abstract 47545.

47292 (N-70-20031) PENETRATION AND INTERACTION OF PROTONS WITH MATTER. PART 1. THEORETICAL STUDIES USING MONTE CARLO TECHNIQUES. Research Report, June 1, 1964–August 31, 1968. Leimdorfer, Martin; Crawford, George W. (eds.) (Southern Methodist Univ., Dallas, Tex. Dept. of Physics). 72p. (NASA-CR-108228; RR-68-2). CFSTI.

The Monte Carlo transport program and its development are described. The type or types of incident nucleons, the energy, energy spectrum, and direction of the particle flux, and type of matter through which the nucleons travel can be selected. The concept of the linear stopping power is discussed and an equation is developed for the total average energy loss by ionization per unit path length per unit density of the stopping materials. The equation is used for part of the collision problems in developing the flexible transport codes. Specific applications are described for simulating transport of neutrons and protons with energies below 400 MeV, depth dose distribution produced by transport of 185-MeV protons through silicon, and lateral leakage of protons from silicon rods bombarded by monoenergetic protons in the energy range of 50 to 187 MeV. (STAR)

47293 (ORNL-TM-3025) LATERAL SPREAD OF HIGH-ENERGY (≤400 MeV) NEUTRON BEAMS AND EARTHSHINE. Alsmiller, R. G. Jr.; Mynatt, F. R.; Gritzner, M. L.; Pace, J. V.; Barish, J. (Oak Ridge National Lab., Tenn.). 3 Aug 1970. 10p. Dep. CFSTI.

Calculated results obtained using the method of discrete ordinates are presented for the cases of zero-width beams of 100- and 400-MeV neutrons normally incident along the axis of a cylindrical shield of silicon dioxide with 5% water by weight. The results include the omnidirectional neutron flux per unit energy as a function of depth and radius in the shield and the neutron and photon dose equivalents as a function of depth and radius in the shield. In the vicinity of well-shielded target areas of high-energy accelerators, the neutrons and photons that diffuse through the ground under the shield, "earthshine," often pose a radiation hazard. Calculated results of the earthshine from a 400-MeV neutron source in a specific geometry are presented and discussed. (auth)

47294 (ORNL-tr-2349) NUCLEAR SHIELDING CALCULATIONS STUDY NO. 07-1. NOTE 9. PHOTON SCATTERING, MONOENERGETIC ISOTROPIC POINT SOURCE, INFINITE MEDIUM. (Ministere des Armees, Paris (France). Direction Technique des Armements Terrestres). Translated for Oak Ridge National Lab., Tenn., from French report. 63p. Dep. CFSTI.

The details of a differential energy flux calculation in a photon scattering problem are given. The photon source is monoenergetic, point-shaped, and isotropic. The absorbing medium is assumed to be infinite. The method used for these calculations is a Monte Carlo method with exponential transformation. The mathematical and physical study is outlined. The calculations were performed on an IBM 7040 computer using the DIPHO code. (M.H.R.)

47295 (ORNL-tr-2366) NUCLEAR SHIELDING CALCULATIONS. NOTE NO. 50. NEUTRON REFLECTION AND TRANSMISSION IN SHIELDS MONTE CARLO METHOD. (Ministere des Armees, Paris (France). Direction Technique des Armements Terrestres). Translated for Oak Ridge National Lab., Tenn.), from French report. 45p. Dep. CFSTI.

A calculation by the Monte Carlo method (code name ALTRAN) of the neutron flux and dose through two flat plates of any given material is described, with application to polyethylene-covered steel shields. Angular flux and dose distribution for reflected and transmitted neutrons were obtained. (M.H.R.)

47296 STOCHASTIC GAMMA-RAY TRANSPORT AND ITS APPLICATION TO SHIELDING CALCULATIONS. Razani, Arsalan. Lafayette, Ind.; Purdue Univ. (1969). 252p. University Microfilms Order No. 70-8954.

Thesis.

A new probabilistic formulation and development of a model for the investigation of gamma ray transport problems is examined. The basic assumption of this model is that gamma ray motion may be sampled at predetermined points. A medium is considered to be filled with a cubic lattice whose unit distance between lattice points may be some fraction of the mean free path, or may be chosen arbitrarily. Each collision in the medium is considered to be either a Compton interaction, a photoelectric reaction, or a pair production reaction. The random walk of gamma rays from one point to another is constructed giving 26 allowed directions of motion, each of which encompasses a portion of a solid angle fraction. Using this model, a new type of stochastic gamma ray transport code is developed based on direct simulation of physical transport process. This code is named PUGT I (Purdue University Gamma Ray Transport I). In another version of the code (PUGT II), capture of gamma rays is taken into account analytically by associating a weight factor to gamma rays. In case of pair production, the history of one photon is followed with the statistical weight doubled. The transmission and reflection of gamma rays for different thicknesses of slabs of aluminum and iron are calculated using the codes. The contribution of annihilation radiation to reflection and transmission is investigated. The results are found to be in good agreement with other calculations and experimental results. PUGT I and PUGT II are three-dimensional general purpose codes. To show the ability of the codes and the power of the lattice model to calculate the transmission of gamma rays in three dimensional complex shielding geometries, the problem of gamma ray streaming through two-legged rectangular concrete ducts was undertaken. (Diss. Abstr. Int., B)

47297 GENERAL METHOD OF BIASING THE ANGLE OF SCATTERING IN MONTE CARLO CALCULATIONS. Burgart, Calvin Edmund. Knoxville, Tenn.; Univ. of Tennessee (1969). 76p. University Microfilms Order No. 70-7550.

Thesis.

The application of the Monte Carlo method to the solution of deep-penetration radiation transport problems requires the use of "importance sampling." A systematic approach to obtaining an importance function is to calculate the solution of the inhomogeneous adjoint transport equation (using the Monte Carlo estimator of the answer of interest as the source term) and to use this adjoint flux (or value function) as the importance function. The adjoint flux is calculated for simplified geometries using one-dimensional discrete ordinates methods. In three-dimensional deep-penetration Monte Carlo calculations the alteration of both the transport and the collision kernel is desirable. The exponential transform is quite useful for altering the transport kernel. However, selection from the altered collision kernel is much more difficult. The approach taken here is to introduce an angular grid with thirty discrete directions fixed in the laboratory coordinate system, along which particles are required to travel. After determining appropriate scattering probabilities and values of the importance function for each of the discrete directions, the selection of the outgoing direction and, hence, energy from the resulting discrete distribution is easily performed. The effects of the discrete angular grid and the capability of angular-biased Monte Carlo have been investigated for neutron transport by comparison with standard Monte Carlo and discrete ordinates calculations, experiment, and exact analytic solutions for several configurations. In all cases the discrete grid alone (no angular biasing) was observed to have no significant effect on the results. Monte Carlo calculations were performed utilizing the exponential transform, nonleakage, source energy biasing, Russian roulette

and splitting plus the angular biasing. The results of these calculations illustrate the general usefulness of this discrete grid approach to angular biasing in several ways. First, meaningful results were obtained with angular biasing at much greater distances from the source than were practically possible with the earlier biasing techniques. The answers, variances, and computer times were all on the same order or better than those obtained with the earlier biasing techniques. Finally, this method utilizing the discrete grid to incorporate angular biasing requires very little human interaction once the adjoint configuration is selected. (Diss. Abstr. Int., B)

Solid-State Physics

Refer also to abstract 46763.

Radiation Effects

Refer also to abstracts 46273 and 46558.

47298 (ANL-Trans-825) POSSIBILITY OF USING A DEFECT-FREE CRYSTAL STRUCTURE TO ACCELERATE CHARGED PARTICLES. Vorob'ev, A. A.; Vorob'ev, S. E. Translated for Argonne National Lab., Ill., from Izv. Vyssh. Ucheb. Zaved., Fiz.; No. 3, 127-8(1969). 7p. Dep. CFSTI.

The author states that the complex problem of developing a crystal accelerator have, to a certain extent, been solved and encouraging results obtained in its other parts. The main part of the problem — obtaining a defect-free atomic structure — remains one of the main problems of modern physics, but solution will probably be obtained for crystals of linear symmetry of the fiber type (asbestos) or of grafted polar molecules with a fixed distribution of atoms along the molecular axis. (L.M.T.)

47299 COLOR CENTERS AND POINT DEFECTS IN IRRADIATED THORIA. Childs, B. G.; Harvey, P. J.; Hallett, J. B. (Chalk River Nucl. Labs., Ont.). J. Amer. Ceram. Soc.; 431-5 (Aug 1970).

The optical absorbance of commercially pure thoria single crystals was measured after oxidizing and reducing treatments, irradiation by 18-MeV protons, 48-MeV ^{16}O ions, and ^{60}Co gamma photons, and thermal annealing at temperatures up to 950°C. For unirradiated specimens, absorption bands previously observed at 2.80, 3.03, and 4.03 eV were confirmed, and additional bands were identified at 1.67, 2.04, 2.45, 3.61, and 4.52 eV. Reduction and irradiation enhanced the 3.03- and 3.61-eV bands but diminished the 2.80-, 4.03-, and 4.52-eV bands. The centers responsible for the two groups of bands are thus presumed to be electron-type and hole-type, respectively. Impurity atoms, also, are probably involved in the centers. Ion irradiation produced an intense blue color in the exposed volume of the specimens, and additional absorption bands appeared at 1.49, 1.80, 2.03, and 2.32 eV. The behavior of these bands on annealing and on subsequent low-exposure gamma irradiation indicated that the corresponding centers are combinations of impurity atoms and oxygen interstitials. (auth)

47300 DIFFUSION AND DEFECT ANNEALING IN SILICON DOPED BY PHOSPHORUS ION IMPLANTATION. Titov, V. V. (Inst. of Atomic Energy, Moscow). Phys. Status Solidi (a); 2: 203-9(16 Jun 1970).

Conductivity profiles and impurity concentration of silicon implanted with 30-keV phosphorus ions (implantation dose 6 C m^{-2}) were studied. The defect annealing was found to terminate practically during the first minutes at T_{ann} = 600 to 900°C. Diffusion redistribution of implanted atoms becomes appreciable after 6 hr at 600°C, after 2 hr at 800°C, and after 2 to 5 min at 900°C. The annealing process at 900°C is accompanied by a considerable change of the defect concentration and therefore of the coefficient D of the radiation-induced diffusion. A calculation of D(x,t) basing on the variation of the phosphorus concentration profile shows that initially the diffusion coefficient in the region of maximum defect concentration is 2 to 2.5 orders of magnitude higher than the coefficient for ordinary diffusion. (auth)

47301 CARRIER TRAPPING BY DEFECT CLUSTERS IN NEUTRON-IRRADIATED SILICON. Sprague, J. A.; Rudee, M. L. (Rice Univ., Houston, Tex.). Phys. Status Solidi (a); 2: 261-5 (16 Jun 1970).

The annealing of the carrier trapping in two types of neutron-irradiated n-type silicon is studied in the temperature range between 400 and 900°C. These annealing data are correlated with those reported previously for defects visible by transmission electron microscopy in the same material. This correlation provides the first direct evidence that the large (2.0 to 4.0 nm) visible defect clusters act as carrier traps as well as lattice strain centers. This conclusion is further justified by the observation by several previous investigators that all of the primary defects and their simple associations in irradiated silicon anneal at temperatures below the range studied in the present experiments. (auth)

47302 DENSITY AND SIZE DISTRIBUTION OF DEFECT CLUSTERS IN NEUTRON-IRRADIATED COPPER. Ruehle, M. (Max-Planck-Institut fuer Metallforschung, Stuttgart); Crump III, J. C. Phys. Status Solidi (a); 2: 257-60(16 Jun 1970).

Error causes and absolute errors in the determination of the density and size distribution of defects in neutron-irradiated copper by means of transmission electron microscopy are discussed. It is shown that the densities and size distributions of defects in equally irradiated foils obtained independently by different authors agree within the error limits. (auth)

47303 USE OF AN ELECTRONIC MICROPROBE FOR STUDY OF ION IMPLANTATION. Legrand, Charles; Bahezre, Claude; Le Duigou, Jacques; Trillat, Jean Jacques (Centre National de la Recherche Scientifique, Meudon, France). Compt. Rend., Ser. B; 271: 88-92(15 Jul 1970). (In French).

Electronic microprobe detection of argon ions accelerated by 20 kV and implanted into various target materials (Al, Ni, Au) facilitates the study of their fixation kinetics and mobilities as a function of the thermal treatments of the targets. The sputtering of a thin layer could be studied by applying this technique. (tr-auth) (France)

47304 RECOMBINATION LUMINESCENCE IN ALKALI HALIDES. Pooley, D.; Runciman, W. A. (Atomic Energy Research Establishment, Harwell, Eng.). J. Phys., C (London); 3: 1815-24 (Aug 1970).

Results are presented of a study of x-ray and electron-excited luminescence in alkali halides in the temperature range 4 to 300°K. Details are given of the spectral distribution and lifetimes associated with the luminescence bands at about 5°K. The lifetime and peak intensities of some bands were measured as a function of temperature, giving parameters characterizing quenching processes. These parameters confirm that many luminescence transitions are nearly forbidden and that the quenching process involves internal radiationless transitions. (auth) (UK)

47305 ELECTRON SPIN RESONANCE OF GAMMA-IRRADIATED BOROGERMANATE GLASSES. Bettinali, Carlo (Univ., Rome); Granati, Paolo; Virtuoso, Giuseppe; Sartori, G. Atti Accad. Lincei., Rend., Cl. Sci. Fis., Mat. Natur.; 47: 313-19(Nov 1969).

Samples studied included: (1) 13.9 mole % Na_2O, 75.7 mole % B_2O_3, 12.7 mole % GeO_2 and (2) 14.6% Na_2O, 18.7% B_2O_3, 67.2% GeO_2. $Na_2B_4O_7$ and Na_2O-GeO_2 glasses were also studied as reference points. The ESR of (1) has a five-line resonance spectrum (g = 2.018, 2.001, and 1.993), and is probably due to an unpaired electron interacting with a ^{11}B atom in an axially symmetric center. The ESR of (2), having a high Ge content, shows a five-line resonance superimposed on a single line having the same g value as the germanate glass. Thermoluminscence was found to occur at a temperature at which the ESR centers are stable. (D.L.C.)

47306 MOESSBAUER STUDY OF ORDER IN 50-50 Fe-Ni ALLOY IRRADIATED BY NEUTRONS AND ELECTRONS. Gros, Y. (Grenoble Univ., Saint-Martin-d'Heres, France); Pauleve, J. J. Phys. (Paris); 31: 459-70(May-Jun 1970). (In French).

Using the Moessbauer technique, 50-50 Fe-Ni alloy in polycrystalline and monocrystalline samples irradiated in a magnetic field by neutrons or electrons was examined. The existence of ordered domains of AuCu type, shown on previous experiments, was revealed by a splitting of the Moessbauer spectrum. Measurement of the quadrupolar shift of the component spectra led to assign them respectively to two kinds of ordered domains whose local fields are differently oriented to the local symmetry axis. The internal field anisotropy is explained in terms of calculated dipolar contributions. The intensities of the lines determine the relative proportions of the ordered domains. The neutron and electron irradiations differ principally in the size of the ordered domains produced, and in the latter case, this gives rise to a different magnetic order. (tr-auth) (France)

47307 ELECTRON PARAMAGNETIC-RESONANCE AND ELECTRON-NUCLEAR DOUBLE-RESONANCE OBSERVATIONS OF DOMAINS IN THE IRRADIATED FERROELECTRICS KH_2AsO_4 AND KD_2AsO_4. Dalal, N. S.; McDowell, C. A.; Srinivasan, R. (Univ. of British Columbia, Vancouver). Phys. Rev. Lett.; 25: 823-6(21 Sep 1970).

A direct observation of ferroelectric domains in x-irradiated

KH_2AsO_4 and KD_2AsO_4 using electron paramagnetic resonance (EPR), and in the case of KH_2AsO_4 also using electron-nuclear double-resonance (ENDOR), is reported. The nature of the observed domain splittings and consequently the effects of an externally applied electric field on the EPR and ENDOR spectra are explained. Moreover, the higher resolution possible with the ENDOR technique, has, for the first time, made it possible to use protons as microscopic probes and to identify in general lines from individual domains in all directions. (auth)

47308 ESR STUDIES OF HYDROGEN TRAPPED IN ALKALI HALIDES BY PROTON IRRADIATION. Virmani, Y. P.; Zimbrick, J. D.; Zeller, E. J. (Univ. of Kansas, Lawrence). Chem. Phys. Lett.; 6: 508-12(1 Sep 1970).

Trapped hydrogen atoms were detected by electron paramagnetic resonance spectroscopy in proton-irradiated KCl and NaCl single crystals at 77°K. The paramagnetic resonance characteristics indicate that the hydrogen atoms closely resemble U_3 centers. (auth)

47309 SEMICONDUCTIVITY IN β-ALANINE. Mookherji, T. (Teledyne-Brown Engineering Co., Huntsville, Ala.); Kulshreshtha, Arun P. Chem. Phys. Lett.; 6: 423-6(1 Sep 1970).

Temperature dependence of electric conductivity and optical transmission and reflection were studied in pure and x-irradiated β-alanine single crystals and powder. A direct allowed transition with room-temperature energy of 5.54 eV was observed. X-ray damage was found to produce a broad absorption band overlapping the fundamental band. (auth)

47310 KINETICS OF RADIATION DAMAGE IN KBr. Treacy, Donald John. Princeton, N. J.; Princeton Univ. (1969). 157p. University Microfilms Order No. 70-8396.

Thesis.

The efficiency of negative ion vacancy formation in KBr as a function of the temperature and the energy deposited in the lattice was measured between 6 and 300°K. The structure of the curves generated was correlated with electronic and ionic processes occurring in various regions of temperature. No evidence was found of a temperature sensitivity of the efficiency that could be attributed to a changing ratio of radiative to nonradiative recombinations of holes and electrons at V_K centers, which had been theoretically predicted by Pooley to influence the number of displacement events occurring during irradiation. Evidence was found to support the conclusion that the ionization of electrons from shallow traps can enhance the efficiency of negative ion vacancy formation. The composite V-absorption in the spectral region of 275 nm was partially resolved. The D_3-band, peaking at 268 nm, was found to display many of the properties previously attributed to the V_4-band. A new V-type absorption peaking at 279 nm was resolved. No evidence of the V_4-band was found and it is suggested that many of the previous reports on the V_4-band may have been a misidentification of the D_3-band. The efficiency of negative ion vacancy formation as a function of temperature displayed three different profiles as a function of the energy deposited in the sample. The first profile, an extrapolation to zero energy deposited, displayed two types of behavior as a function of temperature. In the second region, from 120 to 300°K, the efficiency was controlled by the ionization of electrons from shallow traps. In this region the efficiency increases with an energy of 0.07 ± 0.01 eV. The second efficiency versus temperature profile, for moderate energy depositions, taken at 5×10^{19} eV/cm^3, displayed four efficiency behaviors. At temperatures below 21°K, where the intrinsic α-center is stable, the efficiency is insensitive to the temperature of irradiation. From 80 to 120°K, where the V_1-center becomes unstable, the efficiency was found to decrease as the temperature of irradiation was increased with an energy of 0.02 eV. From 120 to 180°K, the efficiency was found to increase with an energy of 0.07 ± .01 eV with increasing temperature of irradiation. This was attributed to a reaction initiated by electrons ionized from a shallow trap, possibly the F'^*-center. From 180 to 300°K, a decreasing efficiency with an energy of 0.10 ± 0.01 eV is attributed to a radioinduced reaction destroying the stability of the D_3-center. At high energy depositions of the order of 3×10^{20} eV/cm^3, the efficiency of negative ion vacancy formation is a monotonically decreasing function of temperature with an energy of 0.04 eV. The D_3-band was found to bleach with uv light with no loss of F centers. It was found to regenerate by annealing with an energy of 0.11 ± 0.01 eV for temperatures below 215°K and with an energy of 0.29 ± 0.02 eV for temperatures above 215°K. With F-light bleaching, the D_3-band was found to bleach with the loss of approximately ½ of the F centers. The V_{279}-band was found to have: a halfwidth of 0.50 eV, an asymmetry of 1.01, a peak position of 279 nm, and a ratio of oscillator strength to the F-band, f_F/f_{V_1} of 3 : 1. It was found to thermally anneal, destroying F centers with an energy of 0.27 eV. (Diss. Abstr. Int., B)

47311 STUDY OF F TO M CENTER CONVERSION AND EQUILIBRIUM IN X-IRRADIATED KCl. Seager, Carleton Hoover. Princeton, N. J.; Princeton Univ. (1969). 116p. University Microfilms Order No. 70-8390.

Thesis.

Several types of experiments were performed to elucidate the formation and destruction mechanisms for M centers in KCl. Crystals of Harshaw, lead-doped, and zone-refined KCl irradiated at 80°K with 75-kV x rays were warmed up at ¼°K per minute while the concentration of F_2^+ and M centers was periodically monitored. In addition, the temperature and x-ray intensity dependence of the F → M equilibrium constant was measured over the range 200 to 400°K in x-irradiated crystals of these same three purities of KCl. Further experiments measuring the relaxation time for the approach to F → M equilibrium after an x-ray intensity change were also performed. The results of these experiments indicate that F_2^+ centers are the first divacancy centers formed upon warming KCl x-irradiated at 80°K. These centers begin to appear at about 200°K and are eventually converted to M centers. The relaxation experiments imply that during irradiation an electronic equilibrium exists between F_2^+ and M centers; the shift in this equilibrium with a change in x-ray intensity appears to account for the intensity dependence of the F → M equilibrium. Certain aspects of the behavior seen during the slow warmup experiments along with the measured dose independence of the F → M equilibrium constant and its sharp increase above 200°K are shown to be inconsistent with the previously suggested M center formation models involving F or α center migration. A new model for aggregate formation involving the migration of self-trapped holes (V_K centers) is proposed and shown to be consistent with many aspects of the data. Due to the present lack of understanding of the F center growth process, a complete comparison between the theoretical predictions and some of the experimental results could not be made. (Diss. Abstr. Int., B)

47312 SENSITIVITY OF THE BASIC PARAMETERS OF THE RAMAN SPECTRUM OF α QUARTZ TO THE EFFECT OF FAST NEUTRONS. Zubov, V. G.; Osipova, L. P. (Moscow State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 15: 261-3(Sep-Oct 1970).

Translated from Kristallografiya; 15: 313-16(Mar-Apr 1970).

The Raman spectrum of α quartz irradiated with an integrated flux of fast neutrons of 4×10^{19} neutrons/cm^2 was obtained. The change in the frequency, width, and intensity of the fundamental lines caused by the irradiation was investigated by comparing an irradiated sample with a nonirradiated control sample of the same dimensions and orientation. The investigations showed that the number of lines, their frequency, and shape of contour did not change after irradiation. A tendency toward line broadening was detected. The line intensities, whose change amounts to 20 to 40% for the various lines, were the most sensitive to the action of a flux of 4×10^{18} neutrons/cm^2 on the quartz. (auth)

47313 EFFECT OF HARDENING AND SOFTENING IMPURITIES AND OF IRRADIATION ON THERMOLUMINESCENCE AND THERMALLY STIMULATED ELECTRON EMISSION FROM LiF CRYSTALS. Belyaev, L. M.; Knab, G. G.; Urusovskaya, A. A.; Dobrzhanskii, G. F. (Inst. of Crystallography, Moscow). Sov. Phys.-Cryst. (Engl. Transl.); 15: 264-7(Sep-Oct 1970).

Translated from Kristallografiya; 15: 317-21(Mar-Apr 1970).

The thermoluminescence, electron emission, and mechanical properties of LiF crystals (both pure and containing U, Mg, In, and Hg impurities) were compared for various irradiation periods. The results obtained enable the authors to suggest a reason for the impurity and radiation hardening of these crystals. (auth)

47314 NATURE OF RADIATION-INDUCED DEFECTS IN CRYSTALS OF ROCHELLE SALT AND TRIGLYCINE SULFATE. Vibiyi, I. F.; Romanyuk, N. A. (Lvov State Univ.). Sov. Phys.-Cryst. (Engl. Transl.); 15: 274-7(Sep-Oct 1970).

Translated from Kristallografiya; 15: 329-33(Mar-Apr 1970).

The absorption spectra of irradiated (10^6 R) crystals of Rochelle salt and triglycine sulfate and their saturated aqueous solutions were investigated in the range 220 to 1500 nm. It was established that the radiation absorption bands of the crystals in the quartz uv region are due to ions of the gas CO in the radiolysis product complex. (auth)

47315 EPR STUDY OF SUBSTITUTIONAL-ALUMINUM-RELATED HOLE CENTERS IN SYNTHETIC α-QUARTZ. Mackey, John H.; Boss, James W.; Wood, David E. (Carnegie-Mellon Univ., Pittsburgh). J. Magn. Resonance; 3: 44-54(Jul 1970).

An analysis of the anisotropic EPR spectra at 77°K of three unstable paramagnetic centers with ^{27}Al hyperfine structure in x-irradiated α-quartz is presented. These centers are described by models in which a hole is localized in a nonbonding orbital of an

oxygen which is adjacent to an aluminum impurity in a silicon lattice site; there is an interstitial ion H^+, Na^+, or Li^+ associated with this configuration. The structure of these centers is related to the stable compensator-free substitutional-aluminum center reported by Griffiths, Owen, and Ward. Two additional unstable centers with ^{27}Al hyperfine structure, observed at lower concentrations after x-irradiation at 77°K, are reported; one of these centers is a second species with H^+ compensation, while the other is apparently another compensator-free center. The EPR spectra of quartz plates grown on a major rhombohedral seed showed a strong nonrandomness in the distribution of aluminum among the three silicon sites of the unit cell. The preferred site was determined by relating the angular dependence of the spectra to the atomic arrangement in the sample. Using the identification of this site, the directions of the principal EPR interactions were related directly to the bond directions at the paramagnetic center. (auth) (UK)

47316 FAST-ELECTRON CHANNELING INVESTIGATED BY MEANS OF RUTHERFORD SCATTERING. Uggerhoej, E.; Frandsen, F. (Univ. of Aarhus, Denmark). Phys. Rev., B; 2: 582-90(1 Aug 1970).

The Rutherford-scattering and transmission yields for electrons incident on thin single crystals have been measured. For the Rutherford-scattering yield, very pronounced peaks are found whenever the incoming beam is incident on the crystal within a certain critical angle of a low-index direction. The full width at half-maximum for the peak in yield is found to be proportional to Ψ_1, the Lindhard critical angle. Also, the volume of the peak is found to be conserved for gold crystals of thicknesses up to around 5000 Å. Further, experimental investigations of the multiple scattering for single crystals and polycrystalline foils are discussed. (auth)

47317 VACANCY MIGRATION IN HIGH-TEMPERATURE NEUTRON-IRRADIATED MOLYBDENUM. Kulcinski, G. L.; Kissinger, H. E. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. Phys. Status Solidi (a); 2: 267-72 (16 Jun 1970).

High-purity molybdenum was irradiated to a fast neutron fluence of 3×10^{21} neutrons/cm^2 (>0.1 MeV) at 450°C. Irradiation produces an excess of vacancies which in turn causes a decrease in lattice parameter. Recovery during 2-hr postirradiation anneals involves release of vacancies from traps in the 500 to 600°C region and eventual complete recovery at 850°C. The lack of sufficiently deep traps for isolated vacancies above 600°C may be responsible for an apparent temperature threshold for void formation in molybdenum. (auth)

Physical Properties

Refer also to abstracts 46233, 46712, 46789, 46803, 46809, 47004, and 47182.

47318 (INR-1189) SIMPLE MODEL OF LATTICE DYNAMICS FOR MAGNESIUM, COBALT, AND YTTRIUM. PART I. Czachor, Andrzej (Institute of Nuclear Research, Warsaw (Poland)). 1970. 16p. Dep. CFSTI (U. S. Sales Only).

A simple model of lattice dynamics for hexagonal, close-packed structure crystals, based on the elastic data only, is proposed. The model was successfully tested by calculating phonon frequencies for magnesium and comparing them with experimental ones. Using the model, phonon dispersion relations for cobalt and yttrium were calculated. (auth)

47319 (UCRL-71846) SIX LECTURES ON SHOCK-WAVE PHYSICS. Keeler, R. N.; Royce, E. B. (California Univ., Livermore. Lawrence Radiation Lab.). 9 Feb 1970. Contract W-7405-eng-48. 212p. Dep. CFSTI.

The following six chapters are given: (1) experimental techniques, (2) high-pressure equations of state from shock-wave data, (3) stability of the electronic configuration in metals at high pressures, (4) electrical conductivity of condensed media at high pressures, (5) properties of magnetic materials under shock compression, and (6) new experimental developments in shock-wave physics. (M.O.W.)

47320 SPIN SPLITTING, FERMI ENERGY CHANGES, AND ANOMALOUS g SHIFTS IN SINGLE-CRYSTAL AND PYROLYTIC GRAPHITE. Woollam, John A. (Lewis Research Center, Cleveland). Phys. Rev. Lett.; 25: 810-13(21 Sep 1970).

The first observation of spin-split Landau levels in graphite is reported. These are observed in both natural single crystals and in pyrolytic samples. Experimental splittings are compared with the theory of McClure and Yafet. Discrepancy between theory and experiment is partially accounted for by large shifts in the Fermi energy with field. (auth)

47321 ORIGIN OF DIAMAGNETISM IN MgO AND CdO. Mookherji, T. (Teledyne Brown Engineering, Huntsville, Ala.). J. Electrochem. Soc.; 117: 1201-2(Sep 1970).

A microbalance technique was used for the measurement of the magnetic susceptibility of CdO and MgO. Calculations of theoretical ionic susceptibilities were compared with experimental values. (J.G.B.)

47322 THEORY OF THE GALVANOMAGNETIC PROPERTIES OF GRAPHITE. Pospelov, Yu. A. (Moscow Inst. of the National Economy). Sov. Phys.-Solid State (Engl. Transl.); 12: 645-8 (Sep 1970).

Translated from Fiz. Tverd. Tela; 12: 835-40(Mar 1970).

The effect of the energy dependence of the relaxation time on the galvanomagnetic characteristic of graphite is considered phenomenologically. It is shown in particular that the positive sign of the hall coefficient at low temperatures may easily be explained by taking this energy dependence into account. It is accordingly decided that an earlier conclusion regarding a change in the sign of the parameter γ_1 of the electron spectrum of graphite is valid in explaining the galvanomagnetic properties of graphite at low temperatures. (auth)

47323 TEMPERATURE DEPENDENCE OF THE SPECIFIC HEAT AND ELECTRICAL RESISTIVITY OF DYSPROSIUM IN THE VICINITY OF THE NEEL POINT. Amitin, E. B.; Kovalevskaya, Yu. A.; Rakhmenkulov, F. S.; Paukov, I. E. (Inst. of Inorganic Chemistry, Novosibirsk, USSR). Sov. Phys.-Solid State (Engl. Transl.); 12: 599-604(Sep 1970).

Translated from Fiz. Tverd. Tela; 12: 774-80(Mar 1970).

The specific heat and electrical resistivity of dysprosium were measured in the vicinity of the Néel point. From the experimental results, it is shown that there are considerable deviations from the expected proportionality between the magnetic part of the specific heat the the temperature derivative of the electric resistivity. The temperatures corresponding to the extreme values of the properties investigated do not coincide. An attempt is made to determine the form of the function describing the characteristic feature of the specific heat irrespective to the Néel point. (auth)

47324 ZERO PLACZEK MOMENT AND THE n-PHONON CROSS SECTION. Eder, O. J. (Reaktorzentrum, Seibersdorf, Austria). Acta Phys. Austr.; 30: 334-45(1969). (In German).

Use is made of the zero Placzek moment and the phonon expansion of the double differential scattering cross section for thermal neutrons scattered by a polycrystalline solid or a single crystal in order to calculate the contribution of the n-phonon term to the scattering intensity. This procedure can be extended to the case of liquids and anharmonic crystals via a quasi-phonon expansion. (auth)

47325 MEASUREMENT OF THE INTERNAL MAGNETIC FIELD IN V_2O_3 USING THE INELASTIC SPIN-FLIP SCATTERING OF NEUTRONS. Heidemann, Anton (Technische Hochschule, Munich). Z. Phys.; 238: 208-20(1970). (In German).

For the first time the internal magnetic field in a solid was determined by measurement of inelastic spin-flip scattering of slow neutrons using a neutron crystal spectrometer with extremely high energy resolution. A value of (175 ± 15) kOe was obtained in V_2O_3 at a temperature of 105°K. Using a hyperfine coupling constant deduced by Jones, this value corresponds to an ordered magnetic moment of 1.25 μ_B per vanadium ion. (auth)

47326 IMPORTANCE OF MEASURING THE MAGNETIC ANISOTROPY IN THULIUM. Irkhin, Yu. P. (Metal Physics Inst., Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 12: 28-30(5 Jul 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 12: 38-40 (5 Jul 1970).

It is shown that it is possible to separate the crystal-field and anisotropic-exchange theories of magnetic anisotropy. Equations are derived for the magnetic-anisotropy constant at 0°K for the two respective theories: $K_1^{cr}(0) = \alpha_J A_4' \langle J - \frac{1}{2} \rangle$ and $K_1^{exch}(0) = (g-1)D_1 I' J^2$. The constants A_4' and I' are chosen so that the two equations coincide with the experimental value of K_1 for Tb, and K_1 values are calculated for the other heavy rare earths Dy, Ho, Er, and Tm. The maximum difference between the two theories is observed for Tm; hence, measurements of the anisotropy in Tm would be of greatest interest. (D.L.C.)

47327 MAGNETIC PROPERTIES OF $PrCo_5$–$PrCu_5$ ALLOYS. Samarin, B. A. (Moscow Steel and Alloys Inst.). Appl. Phys. Lett.; 17: 196-7(1 Sep 1970).

The magnetic properties of some ternary alloys $PrCo_xCu_{(5-x)}$ in

the range $4.5 \geq x \geq 2$ were investigated. The remanence and coercive force of these alloys, both directly after annealing at 1020°C for 5 hr and after tempering for 4 hr at 390°C, are very low in comparison with similar alloys in the $SmCo_5$–$SmCu_5$ and $CeCo_5$–$CeCu_5$ systems. (auth)

47328 ELECTRON ENERGY BANDS OF VANADIUM IN SEVERAL EXCHANGE POTENTIALS BY THE APW METHOD. Bolemon, Jay Sharon. Columbia, S. C.; Univ. of South Carolina (1969). 193p. University Microfilms Order No. 70-9277. Thesis.

The electron energy bands for bcc vanadium were calculated for several different electron exchange approximations, using the augmented-plane-wave method. The exchange potential customarily used in energy band calculations is the averaged free-electron exchange, which shall be referred to as the full exchange. Very recent work has shown that a reduction of this exchange is necessary in order to get agreement with the experimental density of states for several metals. This has led to the adoption of the Kohn–Sham exchange, which is the exchange at the Fermi surface of an electron gas and is equal to two-thirds of the averaged exchange. The bands for vanadium were calculated at special points in the Brillouin zone for the full exchange and reduced exchanges of 80, 70, and 60% of this value. The reduction to 80% influenced the bands near the Fermi surface to a sufficient extent so that the effect should be detected by experiment. Consequently, the bands were derived for the full and 0.8 cases at 1024 points in the Brillouin zone. In addition, results from atomic calculations are presented which suggest that a more natural way to include exchange is to keep different exchange potentials for central field wavefunctions of different l values. The bands were then approximated by reducing the exchange to the 0.8 value for $l \geq 2$ wavefunctions and retaining the full exchange for the s and p states. This approximation was also carried out for 1024 points. It was found that the l-dependent approach keeps the modification of the density of states that is obtained by reducing the exchange to 0.8 of the full exchange for all components of the APW functions. Therefore, the l-dependent exchange should give good agreement with experiment on this point, as does the 0.8 exchange. However, the l-dependent exchange causes a reordering of the bands at the Fermi surface when compared with the 0.8 bands, and this effect can also be easily detected by experiment. All of the results for the different exchange potentials are compared and discussed. (Diss. Abstr. Int., B)

47329 OPTICAL AND MAGNETIC PROPERTIES OF NpO_2^{+2} DOPED IN $Cs_2UO_2Cl_4$ AND IN $CsUO_2(NO_3)_3$. Leung, Alfred Faiming. Los Angeles; Univ. of California (1969). 126p. University Microfilms Order No. 70-8246. Thesis.

The EPR spectra of NpO_2^{+2} doped in $Cs_2UO_2Cl_4$ and in $CsUO_2(NO_3)_3$ were observed at 4.2°K. The Np^{+6} ion was assumed to have an axial symmetry. The resonances were identified and fitted to the axial spin Hamiltonian. The effect of the axial field of the oxygens of the NpO_2^{+2} complex is assumed to be strong compared to the crystal fields of the ligands, the ground state of the NpO_2^{+2} doped in $Cs_2UO_2Cl_4$ is identified as the $|5f^1\, m_j = \pm 1/2>$ Kramers doublet because it is the only state that gives non-zero $g_\perp$. The nuclear moment of ^{237}Np calculated from this ground state is $2.1\beta_N$. However, if the crystal fields of the ligands are as important as the axial fields of the oxygens, the ground state is $0.693\,|-2^+> +0.316\,|+2^+> -0.648\,|+3^->$ and its Kramers conjugate. This ground state gives the calculated nuclear moment of ^{237}Np as $2.9\beta_N$. The ground state of NpO_2^{+2} doped in $CsUO_2(NO_3)_3$ is identified as $0.800\,|+3^-> -0.517\,|+2^+> +0.307\,|-3^+>$ and its Kramers conjugate. This ground state gives the calculated nuclear moment of ^{237}Np as $2.9\beta_N$. The absorption spectrum of NpO_2^{+2} doped in $Cs_2UO_2Cl_4$ was observed. Five pure electronic levels at 6880, 13277, 15426, 17478, and 19358 cm^{-1} were identified through the vibronic transitions. The ground state and the energy level at 6880 cm^{-1} belong to the $5f^1$ configuration. However, the rest of the observed energy levels do not belong to the $5f^1$ configuration. Most likely they come from an excited configuration which has a hole in the Np–O bond and two electrons in the nonbonding 5f shell. In the absorption spectrum of NpO_2^{+2} doped in $CsUO_2(NO_3)_3$, nine electronic levels were identified through their vibronic patterns and magnetic properties. Four of these levels at 6458, 9421, 17841, and 20815 cm^{-1} are identified as the pure electronic transitions within the $5f^1$ configuration. The other five electronic levels at 13914, 16071, 16093, 17968, and 21021 cm^{-1} come from the excited configuration in which there are two 5f electrons and a hole in the Np–O bond. The g values calculated from the Zeeman effect patterns of the absorption lines at 6458, 9421, 17841, and 20815 cm^{-1} agree roughly with the calculation reported by Eisenstein and Pryce on the spectrum of NpO_2^{+2} doped in $RbUO_2(NO_3)_3$ whose crystal structure is isomorphous to that of $CsUO_2(NO_3)_3$. (Diss. Abstr. Int., B)

47330 FRANCIS BITTER: SELECTED PAPERS AND COMMENTARIES. Erber, T.; Fowler, C. M. (eds.). Cambridge, Mass.; Massachusetts Institute of Technology Press (1969). 559p. $20.00.

This commemorative volume in honor of Francis Bitter contains his principle papers on ferromagnetism, the construction of powerful electromagnets, and optical pumping and double resonance, as well as additional articles recording his achievements in other areas of physics. These papers are grouped into eight sections arranged roughly in chronological sequence and internally unified by subject matter. (M.O.W.)

47331 EFFECTS OF HYDROSTATIC PRESSURE ON MAGNETIC ORDERING OF HEAVY RARE EARTHS. Fleming, G. S.; Liu, S. H. (Ames Lab., Iowa). Phys. Rev., B; 2: 164-6(1 Jul 1970).

The effects of hydrostatic pressure on the magnetic ordering of heavy rare earths are studied through the pressure shift of the electronic energy bands and the effects of this pressure shift on the indirect exchange. It is shown that the change in the ordering temperature of Gd, Tb, and Dy and the variation of the helical turn angle of Tb can be explained in this manner. (auth)

Moessbauer Effects and NMR

Refer also to abstracts 47185 and 47662.

47332 PARAMAGNETIC RESONANCE OF $^{155}Gd^{3+}$ IN THORIA: OBSERVATION OF FORBIDDEN LINES IN THE HYPERFINE STRUCTURE. Bacquet, Gerard; Dugas, Jacques; Bonnet, Michele; Escribe, Claude (Univ., Toulouse). Compt. Rend., Ser. B; 270: 1691-3(29 Jun 1970). (In French).

Forbidden lines in the hyperfine structure of the paramagnetic resonance spectra of the $^{155}Gd^{3+}$ ion in ThO_2 were observed. The angular variation of intensity as a function of the crystal orientation in the magnetic field was studied. (tr-auth) (France)

47333 SPIN ECHO INVESTIGATIONS IN FERROMAGNETICALLY ORDERED GADOLINIUM. Dinteimann, F.; Dormann, E.; Oppelt, A. (Technische Hochschule, Darmstadt, Ger.). Solid State Commun.; 8: 1257-9(15 Aug 1970).

Nuclear spin echo measurements on ^{155}Gd and ^{157}Gd at 4.2°K and 77°K in metallic gadolinium are reported. Values of T_1, T_2, and resonance frequencies at 0 and 10.7 kOe external applied field are given. (auth) (UK)

47334 UEAITR: A NEW COMPUTER PROGRAM FOR ANALYSIS OF NMR SPECTRA: ANALYSIS OF THE PROTON SPECTRUM OF TRIISOPROPYLPHOSPHINE. Johannesen, R. B. (National Bureau of Standards, Washington, D. C.); Ferretti, J. A.; Harris, R. K. J. Magn. Resonance; 3: 84-93(Jul 1970).

The computer program adds iterative evaluation of input parameters to an earlier program (UEANMR II) that makes use of magnetic equivalence factoring to reduce the size of certain matrices. The present program, by iterating on line frequencies rather than energy levels, and by using magnetic equivalence factoring, offers advantages of speed and convenience over previously described computer programs for NMR analysis. The analysis of the proton spectrum of triisopropylphosphine is described as an example. (auth) (UK)

47335 EXPERIMENTAL METHOD FOR DETERMINING THE ABSOLUTE MOESSBAUER FRACTION. Johnson, D. P. (Pratt and Whitney Aircraft, Middletown, Conn.). Nucl. Instrum. Methods; 85: 29-32(1 Aug 1970).

A general two resonant-absorber technique for measuring the absolute recoilless fraction of Moessbauer sources is presented. The technique is similar to the black absorber technique, but does not require a special absorber. The method is independent of source line shape, absorber line shape, and velocity-independent instrumental broadening. (auth)

47336 RECOILLESS FRACTION IN MICROCRYSTALS. Ruppin, R. (Univ. of North Carolina, Chapel Hill). Phys. Rev., B; 2: 1229-35(1 Sep 1970).

The recoilless fraction f in monostomic microcrystals is calculated from a lattice-dynamical model. Its dependence on the physical boundary conditions at the surfaces of the crystallites is shown to follow the rule that f increases with increasing stiffness of the binding to the surrounding medium. A modified form of the Debye approximation, which has been used in the past to explain Moessbauer-effect experiments on microcrystals, is found to yield results which are incompatible with those derived

from lattice dynamics. The reasons for the failure of the Debye approximation to predict the recoilless fraction in microcrystals are discussed. (auth)

Theoretical Physics

Refer also to abstract 47485.

47337 PRIMENENIE ANALOGOVYKH VYCHISLITEL'NYKH MASHIN DLYA ISSLEDOVANIYA DVIZHENIYA ZARYAZHENNYKH CHASTITS. (Use of Analog Computers for Studying Charged-Particle Motion). Kochegurov, V. A.; Razin, V. M.; Trikhanova, N. V. Moscow; Atomizdat (1970). 136p.

The application of specialized computing systems for modeling cnarged particle trajectories is considered; also the motion of charged-particle beams in electric and magnetic fields of different configuration is investigated by the method of mathematical modeling on analog computers. (M.H.R.)

47338 UNCERTAINTY PRINCIPLE. III. Halpern, Otto. Acta Phys. Austr.; 30: 328-33(1969).

Continuing earlier investigations into related problems, the well-known ideal experiment of measuring a momentum with the aid of the Compton effect is studied. It is found that the generally accepted discussions have to be radically modified. This comes about because previously the effect of multiple scattering processes during the time of observation T was not taken into account. It is no longer possible to formulate a general uncertainty relation, since this would depend on the individual properties of the experimental arrangement. The uncertainty product $\Delta p\,\Delta q$ which was previously $\simeq h$, can now be said to be always $\gg h$. (auth)

47339 TEMPORAL EVOLUTION AND THE APPROACH TO EQUILIBRIUM OF A QUANTUM PARTICLE IN A SUDDENLY EXPANDED BOX. Stutz, C.; Schlitt, D. W. (Univ. of Nebraska, Lincoln). Phys. Rev., A; 2: 897-908(Sep 1970).

The time evolution and its implications with regard to the approach to equilibrium of a single-particle system in a suddenly expanded box with perfectly reflecting walls is investigated, using density-matrix techniques. It is shown that the time-dependent quantities exhibit a periodic behavior that is independent of the initial density matrix as long as the dimensions of the system are finite. The period is found to be $2\pi\hbar/E_1$ where E_1 is the ground-state energy of the expanded system. The continuum approximation is employed to determine the explicit time dependence of the particle density of a system initially in thermal equilibrium. It is found that the density for an expansion into a finite volume decays essentially as $1/t$ with small oscillations superposed on this behavior for times ranging from shortly after expansion up to one-fourth the characteristic period. (auth)

47340 TEMPORAL EVOLUTION AND THE APPROACH TO EQUILIBRIUM OF A SYSTEM OF NONINTERACTING QUANTUM PARTICLES. Stutz, C.; Schlitt, D. W. (Univ. of Nebraska, Lincoln). Phys. Rev., A; 2: 909-17(Sep 1970).

The temporal evolution and its implications in regards to the approach to equilibrium of a system of noninteracting particles that has undergone a sudden expansion is studied. It is assumed that the system is initially in thermal equilibrium. It is shown that the particle density approaches an equilibrium density essentially as $1/t$ for times shortly after expansion up to one-half the characteristic period. This period is the same as for a single-particle system. An expression is derived for the particle density that is valid for Bose, Fermi, and Boltzmann particles. The density for Bose and Fermi particles is compared with that found for Boltzmann particles. (auth)

47341 NONADIABATIC MOTION OF A CHARGED PARTICLE IN A UNIFORM TIME-VARYING MAGNETIC FIELD. Glikman, L. G.; Kel'man, V. M. Sov. Phys.-Tech. Phys. (Engl. Transl.); 14: 1151-2(Feb 1970).

Translated from Zh. Tekh. Fiz.; 39: 1534-6(Aug 1969).

A case of nonadiabatic motion of a charged particle that has not previously been noted in the literature is described. The mathematical analysis is given. (M.O.W.)

47342 COMMENT ON A PAPER ON THE SOLUTION OF THE EQUATION GOVERNING THE INITIAL DISTRIBUTION FUNCTION FOR ELECTRONS. Paveri-Fontana, S. (Univ. of California, Berkeley). Energ. Nucl. (Milan); 16: 787-8(Dec 1969).

In the paper by Ballerio, Bonalumi, and Cavalleri (Energ. Nucl. (Milan), 16: 455-62(1969)) on the above subject, the author feels the scattering kernel in the integral equation for the distribution function is not correctly normalized. Also, he presents a much shorter alternative derivation of the equation for the distribution function for the case when $(\lambda/c) = \tau_0$. See also NSA 23: 39484. (L.M.T.)

47343 RELATIVISTIC COMPTON ENERGY EXCHANGE. Corman, E. Gary (Univ. of California, Livermore). Phys. Rev., D; 1: 2734-7(15 May 1970).

A relativistically accurate table of values is calculated for the Compton energy exchange rate between photons in a Planckian distribution at temperature T_R varying from 5 to 50 keV and electrons in a nondegenerate Maxwell–Boltzmann distribution at temperatures T_e varying from 0 to 100 keV. (auth)

47344 THERMAL PHYSICS. SECOND EDITION. Morse, Philip M. New York; W. A. Benjamin, Inc. (1969). 441p. $16.00.

Twenty-seven chapters on thermodynamics, kinetic theory, and statistical mechanics are included. Separate abstracts were prepared for four chapters on statistical mechanics. (M.H.R.)

For abstracts of individual chapters see: 47345–47348.

47345 QUANTUM STATISTICS. pp 322-33 of Thermal Physics. /Morse, Philip M. New York; W. A. Benjamin, Inc. (1969).

The following topics are discussed: occupation members, Maxwell–Boltzmann particles, bosons and fermions, comparison among the three statistics, and distribution functions and fluctuations. (M.H.R.)

47346 BOSE–EINSTEIN STATISTICS. pp 334-46 of Thermal Physics. /Morse, Philip M. New York; W. A. Benjamin, Inc. (1969).

The properties of a gas of bosons are studied. Two cases are considered: a gas of photons and a gas of material particles, such as helium atoms. (M.H.R.)

47347 FERMI–DIRAC STATISTICS. pp 347-63 of Thermal Physics. /Morse, Philip M. New York; W. A. Benjamin, Inc. (1969).

The thermal properties of a gas of fermions are worked out, to compare with those of a gas of bosons and with those of a perfect gas of Maxwell–Boltzmann particles, particularly in the region of degeneracy. Topics covered are: general properties, intermediate temperatures, the completely degenerate fermion gas, low temperatures, electrons in metals, conduction electrons in good conductors, electrons as a fermion gas, and superconductivity. (M.H.R.)

47348 INTERPARTICLE FORCES. pp 364-88 of Thermal Physics. /Morse, Philip M. New York; W. A. Benjamin, Inc. (1969).

The following topics are discussed: particles and wave functions; symmetric wave functions; antisymmetric wave functions; bound states and free states; the effect of particle spin; larger numbers of particles; deuterium and helium nuclei; liquid helium II, metastable equilibrium; homonuclear diatomic molecules, para- and orthohydrogen, and ortho- and paradeuterium. (M.H.R.)

47349 FOURTH PICTURE IN QUANTUM MECHANICS. Marcus, R. A. (Univ. of Illinois, Urbana). J. Chem. Phys.; 53: 1349-55(15 Aug 1970).

A quantum-mechanical counterpart to the classical mechanical variation of constants method is derived, with initial values of coordinates and momenta as "constants." Use is made of a formal operator solution for nonautonomous or autonomous systems in classical mechanics, and of the correspondence between Poisson brackets and commutators. An alternative unified Lie-algebraic derivation is also given. It is shown that the Schroedinger, Heisenberg, and interaction pictures in quantum mechanics do not correspond directly to the method of classical mechanical variation of these "constants." A fourth picture, termed "mixed interaction," is introduced and shown to so correspond. It complements the previous three in a symmetrical manner, bearing the same relation to the Heisenberg picture that the Schroedinger picture bears to the interaction one. The group-theoretic relationship to the interaction picture is noted, as is the relation to the usual variation-of-constants method in wave mechanics. For completeness, the classical counterparts of the Heisenberg and interaction pictures are also given. The present results arose from a comparison of quantum and classical treatments of collisions. (auth)

47350 SCHROEDINGER PICTURE FOR THE NAMBU–TAKABAYASI EQUATION AND TRANSITION FORM FACTORS. Morita, Katsusada (Nagoya Univ.). Progr. Theor. Phys. (Kyoto); 43: 1071-84(Apr 1970).

It is shown that the Nambu–Takabayasi infinite-component wave

equations in a particular class of Lorentz frames moving along the common z axis are formally equivalent to the Schroedinger equation for the "hydrogen atom" in an internal space of three dimensions. The "relative distance" between two "constituents" receives a kind of dilatation under the action of the physical Lorentz transformations along the z axis. The dilatation is shown to manifest itself as the transition form factors. The transition form factors are evaluated between arbitrary discrete (bound) states of the equation in closed form and then show that the result coincides with those obtained by a purely algebraic method. (auth)

47351 FORMULATION OF THE UNCERTAINTY PRINCIPLE ACCORDING TO THE HYDRODYNAMIC MODEL OF QUANTUM MECHANICS. Wilhelm, H. E. (Colorado State Univ., Fort Collins). Progr. Theor. Phys. (Kyoto); 43: 861-9 (Apr 1970).

The uncertainty principle is formulated according to the hydrodynamic model of quantum mechanics. Tensorial uncertainty relations are established that relate the minimum uncertainty products to the quantum stresses in which the microphysical system is embedded. It is concluded that exterior perturbations due to measuring devices are not essential for the indeterminacy phenomenor As an illustration, the hydrodynamic uncertainty relations are applied to elementary quantum systems. (auth)

47352 REMARKS ON THE RETARDED AND ADVANCED GREEN'S FUNCTIONS. Ramos, J. G.; Gomes, A. A. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: 245-56(1969).

The connection between time correlation and retarded, advance Green's functions is discussed in a systematic way. The occurrence of a time-independent contribution to the time-correlation function is connected to commutator-defined Green's function, and a simple rule is given for its calculation when a suitable decoupling is available. (auth)

47353 VECTOR STATES ON ALGEBRAS OF OBSERVABLES AND SUPERSELECTION RULES. I. VECTOR STATES AND HILBERT SPACE. Sushko, V. N.; Khoruzhii, S. S. Teor. Mat. Fiz.; 4: 171-93(Aug 1970). (In Russian).

An exhaustive investigation of vector states on arbitrary W* algebra of observables $R \neq \mathcal{B}(\mathcal{H})$ is carried out. Properties of vector states are reformulated and studied in terms of their Hilbert space images, i.e., the sets of vectors in $\mathcal{H}$ representing a given vector state. The properties of pure vector states are described in detail and the necessary and sufficient condition is found under which all vector states are represented by unit rays in $\mathcal{H}$. The special class of quantum theories is studied for which $\mathcal{H}$ coincides with the closure $\mathcal{H}_p$ of linear hull of vectors representing pure states. The algebra R is proved to belong to this class if and only if it is a direct orthogonal sum of type factors. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 46514, 47392–47394, 47533, and 47534.

Electromagnetic

Refer also to abstracts 46512 and 47396.

47354 (CONF-690557-(Vol.1), pp 193-5) PLANNED EXPERIMENT FOR THE INVESTIGATION OF HYPERNUCLEAR γ RAYS. Lynen, Uli (European Organization for Nuclear Research, Geneva (Switzerland)).

A planned experiment for the γ deexcitation of excited hypernuclei is described. The stopped K^- beam of sufficient intensity and the experimental setup are discussed. (J.F.P.)

47355 (LNF-70/36) ELECTRON-POSITRON ELASTIC SCATTERING AT HIGH ENERGIES. Note No. 487. Bartoli, B.; Coluzzi, B.; Felicetti, F.; Goggi, G.; Marini, G.; Massa, F.; Scannicchio, D.; Silvestrini, V.; Vanoli, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 22 Jul 1970. 13p. (CONF-700806-36). Dep. CFSTI (U. S. Sales Only).

From 15th International Conference on High Energy Physics, Kiev, USSR.

The production of new J^{PC} neutral bosons was sought in $e^+ + e^-$ interactions at the Adone storage ring. The energy of the incident particles was fixed at values between 0.8 and 1.0 GeV. Comparing the observed wide-angle e^+e^- elastic scattering rate, a test of the validity of quantum electrodynamics is obtained with squared space-like momentum transfers to the virtual photon up to about 1.7 $(GeV/c)^2$. It is concluded that in the energy range explored the experimental data show a slope and an absolute value in agreement with the predictions of quantum electrodynamics to within the experimental error of about 10%. (J.F.P.)

47356 (LNF-70/38) REPORTS PRESENTED AT "15th INTERNATIONAL CONFERENCE ON HIGH ENERGY PHYSICS," KIEV (USSR), AUGUST–SEPTEMBER 1970. Note No. 489. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 24 Jul 1970. 43p. (CONF-700806). Dep. CFSTI (U. S. Sales Only).

Three papers are included in the report on experiments carried out at the Adone storage ring; a separate abstract is prepared for each paper. (L.B.S.)

For abstracts of individual papers see: 47357–47359.

47357 (LNF-70/38, pp 3-20) BHABHA SCATTERING BY e^+,e^- COLLIDING BEAMS IN THE GeV REGION. Borgia, B.; Conversi, M.; Paoluzi, L.; Scandale, W. (Rome Univ. (Italy). Istituto di Fisica); Barbiellini, G.; Grilli, M.; Nicoletti, G.; Spillantini, P.; Visentin, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati); Mulachie, A. (Padua Univ. (Italy). Istituto di Fisica). (CONF-700806-33).

The Bhabha scattering process $e^+ + e^- \rightarrow e^+ + e^-$ was investigated in an experiment carried out at the Frascati storage ring, at total energies of the colliding beams ranging from 1.5 to 2.4 GeV. The results of a preliminary analysis of data are reported. (L.B.S.)

47358 (LNF-70/38, pp 21-9) MUON PAIR PRODUCTION BY e^+,e^- COLLIDING BEAMS IN THE GeV REGION. Borgia, B.; Ceradini, F.; Paoluzi, L.; Santonico, R. (Rome Univ. (Italy). Istituto di Fisica); Barbiellini, G.; Grilli, M.; Visentin, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati); Grianti, F. (Genoa Univ. (Italy). Istituto di Fisica). (CONF-700806-34).

Measurements of $e^+e^- \rightarrow \mu^+\mu^-$ interactions at the Frascati storage ring are extended to $q^2 = 4E^2 \sim 4$ $(GeV)^2$. The results are consistent with the hypothesis of muon-electron universality and the validity of quantum electrodynamics at the large time-like momentum transfers involved in the experiment. (L.B.S.)

47359 (LNF-70/38, pp 31-43) HADRON PRODUCTION BY e^+-e^- COLLIDING BEAMS IN THE GeV REGION. Barbiellini, G.; Grilli, M.; Spillantini, P.; Visentin, R. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati); Mulachie, A.; Nigro, M. (Padua Univ. (Italy). Istituto di Fisica); Conversi, M.; Paoluzi, L. (Rome Univ. (Italy). Istituto di Fisica); Zorn, G. T. (Maryland Univ., College Park). (CONF-700806-35).

A preliminary analysis is made of hadron production in the interactions $e^+ + e^- \rightarrow \pi^+ + \pi^-$ and $e^+ + e^- \rightarrow m\pi^+ + m\pi^- + n\pi^0$ at 1.6 to 2.0 GeV, where $n \geq 0$ if $m > 1$ and $n \geq 1$ if $m = 1$, and where hadrons are indicated for simplicity as pions (π). (L.B.S.)

47360 ASYMMETRY IN π^+ PHOTOPRODUCTION FROM A POLARIZED TARGET AT 5 AND 16 GeV. Morehouse, C. C. (Univ. of California, Berkeley); Borghini, M.; Chamberlain, O.; (and others). Phys. Rev. Lett.; 25: 835-8(21 Sep 1970).

The asymmetry of the cross section for $\gamma p \rightarrow \pi^+ n$ from a polarized target at 5 and 16 GeV was measured. The range of four-momentum transfer was $0.02 \leq -t \leq 1.0$ GeV^2. The π^+ mesons were produced in a polarized butanol target and detected with the Stanford Linear Accelerator Center 20-GeV/c spectrometer. A sizable asymmetry was found at both 5 and 16 GeV, a typical value being -0.6 near $-t = 0.3$ GeV^2. A small amount of data on the asymmetry of other photoproduction processes was also obtained. (auth)

47361 EXPERIMENTAL LIMIT FOR THE DECAY MODE $\eta \rightarrow \pi^0\gamma\gamma$. Schmitt, D. (CERN, Geneva); Bunyatov, S.; Zavattini, E.; Deinet, W.; Mueller, H.; Staudenmaier, H. M. Phys. Lett.; 32B: 638-40(31 Aug 1970).

An analysis was made of 6170 $\pi^-p \rightarrow n\eta^0$ events selected by a neutron missing-mass spectrometer and iron-plate spark chambers set-up. From the complete kinematical reconstruction of the events with 4γ's, $R = \Gamma(\eta \rightarrow \pi^0\gamma\gamma)/\Gamma(\eta \rightarrow$ all neutrals$) = (1.6 \pm 4.7)\%$ was found. (auth)

47362 FEASIBILITY OF AN EXPERIMENT IN WHICH HADRONS ARE PRODUCED BY TWO PHOTONS FROM THRESHOLD TO EXTREMELY HIGH ENERGIES. Balakin, V. E.; Budnev, V. M.; Ginzburg, I. F. (Mathematics Inst., Novosibirsk, USSR). JETP Lett. (USSR) (Engl. Transl.); 11: 388-90(5 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 559-62(5 Jun 1970).

A mechanism of hadron production by photons is described which is amenable to observation in accelerators with opposing e^-e^- or e^+e^- beams. The cross section for this process is practically independent of the total effective mass of the reaction products and increases as $\ln^2 E/m$ with increasing beam energy E. The colliding electrons are decelerated and emit bremsstrahlung photons, which in turn condense into hadrons. (J.F.P.)

Weak

Refer also to abstract 47421.

47363 (CONF-690557-(Vol.2), pp 753-7) MEASUREMENT OF THE K^- CASCADE TIME IN LIQUID HELIUM. Bunnell, K.; Derrick, M.; Fields, T.; Hyman, L. G.; Keyes, G. (Argonne National Lab., Ill.); Fetkovich, J. G.; McKenzie, J.; Wang, I-T. (Carnegie-Mellon Univ., Pittsburgh, Pa.).

A helium bubble chamber was exposed to a stopping K^- beam in order to measure the cascade time of K^- in liquid helium. The average cascade time is defined as $T_c = \tau(N_d/N_s)$, where τ is the mean life for the decay of K^-, N_d is the number of K^- observed to decay at rest, and N_s is the total number of K^-'s stopping in the chamber. (J.F.P.)

Strong (Baryon-Induced)

Refer also to abstracts 47466, 47481, and 47561.

47364 (CEA-N-1221) STUDY OF THE $pp \rightarrow pp\pi^+\pi^-$ REACTION AT 8 GeV/c. Tran Ha Anh (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Mar 1970. 94p. (In French). Dep. CFSTI (U.S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

The $pp \rightarrow pp\pi^+\pi^-$ reaction was studied, using results obtained from the two meter bubble chamber at CERN, with an incident beam of 8 GeV/c protons. The cross sections for the various resonances occurring in this reaction were calculated; the most interesting features of the reaction were discussed and a general analysis of the mechanisms was made. Experimental results were compared to the results obtained using modified Deck and Berger models. The $pp \rightarrow \Delta^{++}\Delta^0$ reaction was also studied using periph-

eral models, with or without absorption, and then with the exchange of a Regge trajectory. (auth) (France)

47365 (CONF-690557-(Vol.1)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON HYPERNUCLEAR PHYSICS HELD AT ARGONNE NATIONAL LABORATORY, MAY 5-7, 1969. VOLUME I. Bodmer, A. R.; Hyman, L. G. (eds.) (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 520p. Dep. CFSTI.

The conference included 18 papers. An individual abstract was prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 46990, 47354, 47366-47371, 47378-47380, and 47459-47465.

47366 (CONF-690557-(Vol.1), pp 5-50) Λ AND Σ INTERACTIONS WITH PROTONS. Alexander, Gideon (Tel Aviv Univ. (Israel). Dept. of Physics and Astronomy).

The general features of the $\Sigma^+ + p$, $\Sigma^- + p$, and $\Lambda + p$ interaction data are reviewed. The $\Lambda + p$ low-energy scattering-parameter experiments are described, and the evidence for a Δp resonance is discussed. (J.F.P.)

47367 (CONF-690557-(Vol.1), pp 159-92) HYPERNUCLEAR PHYSICS USING PHOTOGRAPHIC EMULSION. Davis, D. H. (University Coll., London (England). Dept. of Physics); Sacton, J. (Brussels Univ. (Belgium)).

A review of hypernuclear physics using the emulsion technique is given. Binding energy values, excited states of hypernuclei, positive pion decays, spins, branching decay ratios, final-state interactions, nonmesonic decays, and lifetimes are considered. (J.F.P.)

47368 (CONF-690557-(Vol.1), pp 199-221) WHAT'S NEW AND OLD IN THE RANGE-ENERGY RELATION. Heckman, Harry H. (California Univ., Berkeley. Lawrence Radiation Lab.).

The range-energy relation for hypernuclei in nuclear emulsions is discussed. The technical details of the range measurement for various particles are considered. (J.F.P.)

47369 (CONF-690557-(Vol.1), pp 222-9) HYPERON MASS MEASUREMENTS IN NUCLEAR EMULSION. EUROPEAN K^- COLLABORATION. Davis, D. H. (University Coll., London (England)).

The mass of the Λ hyperon was determined in nuclear emulsions from the analysis of samples for different range intervals of the decay negative pion. The mean values for this Λ hyperon mass are listed. Also some preliminary results are given for the range of the Σ^+ hyperons and their mass. (J.F.P.)

47370 (CONF-690557-(Vol.1), pp 403-37) MASS-4 HYPERNUCLEI IN THE ANL-CMU HELIUM BUBBLE CHAMBER. McKenzie, J. (Carnegie-Mellon Univ., Pittsburgh, Pa.).

Recent experimental results for mass-four hypernuclei that were obtained in bubble chambers as an independent technique from emulsions are considered. The hyperfragments $\Lambda-{}^4H$ and $\Lambda-{}^4He$ are treated. The binding energies, production rates, and lifetimes are discussed. (J.F.P.)

47371 (CONF-690557-(Vol.1), pp 438-50) MEASUREMENT OF THE $\Lambda-{}^4H$ LIFETIME AND SEARCH FOR $\Lambda-{}^3H$ PRODUCTION IN K^--FREON INTERACTIONS. Murphy, C. T.; Church, T.; Morfin, J.; Ring, H. (Michigan Univ., Ann Arbor); Fortney, L. (Duke Univ., Durham, N. C.).

The production of $\Lambda-{}^4H$ and $\Lambda-{}^3H$ in stopped K^- reactions with freon in a bubble chamber is studied. The lifetime of $\Lambda-{}^4H$ was measured from the decay $\Lambda-{}^4H \rightarrow {}^4He + \pi^-$. The decay $\Lambda-{}^3H \rightarrow {}^3He + \pi^-$ was also found, but there were not enough events to determine the lifetime of this hypernucleus. (J.F.P.)

47372 (CONF-690557-(Vol.2), pp 708-47) PRESENT PROBLEMS AND FUTURE OUTLOOK IN Λ-HYPERNUCLEAR PHYSICS. Dalitz, R. H. (Oxford Univ. (England). Dept. of Theoretical Physics).

The review of Λ-hypernuclear physics covers the Λ-N interaction, hypernuclear B_Λ values and three-body ΛNN interactions, Λ-hypernuclear states, weak Λ-hypernuclear decay, and the well depth D_Λ for nuclear matter. (J.F.P.)

47373 (CONF-690557-(Vol. 2), pp 748-52) Λ^0 TRAPPING FOLLOWING THE ABSORPTION OF STOPPING K^- AND Σ^- IN LIQUID NEON. Bugg, W. M.; Condo, G. T. (Oak Ridge National Lab., Tenn. Tennessee Univ., Knoxville); Cohn, H. O. (Oak Ridge National Lab., Tenn.); McCulloch, R. D. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center); Garrett, N. E.; Tucker, L. M.; Moulder, J. (Tennessee Univ., Knoxville).

An experiment is reported which permits an unambiguous determination of the hyperfragment production rate resulting from Σ^- capture in neon. A bubble chamber filled with a mixture of neon and hydrogen was exposed to a beam of slow negative kaons. The lambda momentum spectrum from Σ^- (produced from $K^- + p \rightarrow \Sigma^- + \pi^+$ interactions) is shown. The hyperfragment production rate following Σ^- absorption by neon is found to be 0.27 ± 0.03. (J.F.P.)

47374 (CONF-690557-(Vol.2), pp 852-61) Λ_p SCATTERING FOR p_Λ = 300 TO 1200 MeV/c: PRELIMINARY RESULTS. Kadyk, J. A.; Trilling, G. H.; Alexander, G.; Gaposchkin, P. J. (California Univ., Berkeley).

An experiment is described in which the rate of Λ production is enhanced by the addition of a platinum plate inside the hydrogen bubble chamber as a target for a K^- beam. Preliminary results from this experiment are discussed. The events $\Lambda + p \rightarrow \Lambda + p$, $\Lambda + p \rightarrow \Sigma^0 + p$, and $\Lambda + p \rightarrow \Lambda + p + \pi^0$ are fitted, and the momentum distributions of free Λ decays are shown. (J.F.P.)

47375 (CONF-690557-(Vol.2), pp 925-9) EXPERIMENTAL RESULTS ON Λ-NUCLEON INTERACTIONS IN HYPERFRAGMENTS. Rao, N. K. (Tata Inst. of Fundamental Research, Bombay (India)); Gurtu, A.; Singh, M. B. (Punjab Univ., Chandigarh (India)); Swami, M. S. (Aligarh Muslim Univ. (India)).

A brief summary of results obtained on hyperfragments in an emulsion stack exposed to a 350 MeV/c separated K^- beam is presented. The B_Λ values of light hyperfragments, the ratio of π^+ to π^- decay of $\Lambda-{}^4He$, the ratio of nonmesic to π^- mesic decay of light hyperfragments, and the spin dependence of the Λ + N weak interaction are discussed. (J.F.P.)

47376 INVESTIGATION OF THE $\Lambda-{}^6Li$ HYPERFRAGMENT. Gerber, J. P. (CRN, Strasbourg); Bechdolff, A.; Baumann, G. Lett. Nuovo Cim.; 4: 176-8(1 Aug 1970). (In French).

Of 347 mesic hyperfragments analyzed only one event could be interpreted by the reaction $\Lambda-{}^6Li \rightarrow \pi^- + p + p + {}^4He$. It is found impossible to be certain that the peak observed in the relative energy distribution corresponds to the passage of a $\Lambda-{}^6Li$ state and not to a possible excited state of $\Lambda-{}^{10}Be$. (J.F.P.)

47377 STRUCTURE IN THE DIFFERENTIAL CROSS SECTION OF THE REACTION $p + p \rightarrow p + M$ ($M < 2.1$ GeV) FOR $|t| < 0.8$ $(GeV/c)^2$ AT 29 GeV/c. Ellis, W. E.; Kinsey, R. R.; Morris, T. W.; Panvini, R. S.; Turkot, F. (Brookhaven National Lab., Upton, N. Y.). Phys. Lett.; 32B: 641-4(31 Aug 1970).

Bubble chamber and spectrometer data are combined to study the differential cross section, $d\sigma/dt$, of the reaction $p + p \rightarrow p + M$ for $|t| < 0.8$ $(GeV/c)^2$ and $M < 2.1$ GeV. The spectrometer gives high statistics on the variation of the cross section with M and t while the bubble chamber data reveals the constitution of M. (auth)

Strong (Meson-Induced)

Refer also to abstract 46511.

47378 (CONF-690557-(Vol.1), pp 368-402) PROPERTIES OF $\Lambda-H^3$. Keyes, G. (Argonne National Lab., Ill.).

The properties of $\Lambda-{}^3H$ were studied using a stopping K^- beam in a helium bubble chamber. The production rate was found to be $1.8\ (10)^{-3}$ per stopping K^-. The lifetime was determined to be $2.64\ (10)^{-10}$ seconds using 27 unambiguous two-body decay events $\Lambda-{}^3H \rightarrow \pi^- + {}^3He$. Also an estimate of the two-body decay branching ratio 0.36 was used to find a binding energy of 0.11 MeV. The combined result from all reported direct measurements for the binding energy is 0.10 MeV. (J.F.P.)

47379 (CONF-690557-(Vol.1), pp 451-85) HYPERON PRODUCTION BY K^- ABSORPTION IN NUCLEI. Fetkovich, J. G. (Carnegie-Mellon Univ., Pittsburgh, Pa.).

A review of some of the most recent experimental work of the production of Σ and Λ by negative kaon absorption by deuterium and helium nuclei at rest is presented. Kaon absorption in deuterium, the production of $\Lambda\pi$, Σ^-, and Σ^+ in helium, and comparison with theory are discussed. (J.F.P.)

47380 (CONF-690557-(Vol.1), pp 486-92) TWO NUCLEON ABSORPTION OF K^- MESONS IN DEUTERIUM. Veirs, V. R.; Burnstein, R. A.; Novak, D. P. (Illinois Inst. of Tech., Chicago).

The first direct measurements of two-nucleon branching ratios for K^- mesons in deuterium are obtained in an experiment involving stopping K^- mesons in a bubble chamber. The production rates found relative to stopping K^- are: $R(K^-d \rightarrow \Sigma^-p) = 0.505 \pm 0.036\%$ $R(K^-d \rightarrow \Sigma^0n) = 0.376 \pm 0.040\%$; $R(K^-d \rightarrow \Lambda n) = 0.372 \pm 0.038\%$. The total two-nucleon production rate is $1.25 \pm 0.06\%$. (auth)

47381 (CONF-690557-(Vol.2), pp 758-75) DECAY ANALYSIS OF A $\Sigma-B^{11}$ AND TWO POSSIBLE INTERPRETATIONS FOR A DOUBLE HYPERFRAGMENT. Catala, J.; Senent, F.; Tejerina,

A. F.; Villar, E. (Valencia Univ. (Spain). Instituto de Fisica Corpuscular).

A systematic search for interactions with three or more centers, produced by 6-GeV/c K^- in photographic emulsion, was carried out. Two of these events were interpreted by the formation and decay of special hyperfragments. The first event corresponds to the emission of two hyperfragments starting from the first interaction center and is interpreted assuming the formation and decay of a cascade hyperfragment $\Xi^-{}^{11}B$. The second event shows three chained centers. The first center is produced by the primary interaction, and the two other centers are joined to the primary center by two connecting tracks. This event is explained as a nucleonic aggregate $\Lambda\Lambda^-{}^{11}C$. The interpretation of these events is given in detail. (J.F.P.)

47382 (CONF-690557-(Vol.2), pp 862-84) REACTIONS OF STOPPING K^- IN HELIUM. Katz, P. A. (Minnesota Univ., Minneapolis); Bunnell, K. (Northwestern Univ., Evanston, Ill.); Derrick, M.; Fields, T.; Hyman, L. G.; Keyes, G. (Argonne National Lab., Ill.).

The results of a systematic study of a sample of K^- interactions at rest in helium in a bubble chamber are presented. An attempt was made to assign every event to a particular reaction and thus measure branching ratios for the many different final states. The fraction of multinucleon K^- capture and the probability of Σ conversion in these events can be estimated. (J.F.P.)

47383 (CONF-690557-(Vol.2), pp 889-95) KAON MASS MEASUREMENT FROM KAONIC ATOM X RAYS. Kunselman, Raymond; Wiegand, Clyde E. (California Univ., Berkeley. Lawrence Radiation Lab.).

Previous data from measurements on several x-ray transitions of kaonic atoms are presented for a new determination of the mass of negatively charged kaons. The results given are preliminary, and the method is not statistically as accurate as the emulsion method but it can be improved. (J.F.P.)

47384 (CONF-690557-(Vol.2), pp 930-8) STUDY OF Λp MASS SPECTRUM FROM THE REACTION: $K^-D \rightarrow \pi^-p\Lambda$ AT REST. Tan, Tai Ho (Stanford Linear Accelerator Center, Calif.).

The reaction $K^- + d \rightarrow \pi^- + p + \Lambda$ at rest was studied after an exposure of a deuterium bubble chamber to a low-energy separated K^- beam. In particular a detailed analysis of the Λp mass spectrum near the 2129 MeV region was carried out to determine the nature of this enhancement. (J.F.P.)

47385 (CONF-690557-(Vol.2), pp 939-50) STUDY OF $\Sigma^- + p \rightarrow \Lambda + n$ AND $\Sigma^- + p \rightarrow \Sigma^0 + n$ REACTIONS AT P_{Σ^-} BETWEEN 0 AND 600 MeV/c. Yamamoto, S. Steven; Stephen, David; Meisner, Gerald W.; Kofler, Richard R.; Hertzbach, Stanley S.; Button-Shafer, Janice (Massachusetts Univ., Amherst); Yamin, Peter; Berley, David (Brookhaven National Lab., Upton, N. Y.).

Preliminary results are presented from the interactions $\Sigma^- + p \rightarrow \Lambda(\Sigma^0) + n$ at 0 to 600 MeV/c in a bubble chamber. The branching ratio for these interactions and the Λp system are studied. (J.F.P.)

47386 NONSTRANGE BOSON RESONANCES PRODUCED IN $\pi^+ - d$ INTERACTIONS AT 9 GeV/c. Armenise, N. (Univ., Bari, Italy. Istituto Nazionale di Fisica Nucleare, Bari, Italy); Ghidini, B.; Picciarelli, V.; (and others). Lett. Nuovo Cim.; 4: 199-205(1 Aug 1970).

The bosons ρ, f and a peak at 1.73 GeV in $\pi^+ + d \rightarrow 2p + \pi^+ + \pi^-$, $\pi^+ + d \rightarrow 2p + \pi^+ + \pi^- + \pi^0$, and $\pi^+ + d \rightarrow 2p$ + neutrals interactions at 9 GeV/c in a deuterium bubble chamber are studied. Also A_1^0, A_2^0 and a P resonance state are studied in the $(\rho\pi)^0$ system in $\pi^+ + n \rightarrow p + \pi^+ + \pi^- + \pi^0$ interactions. (J.F.P.)

47387 MEASUREMENT OF THE POLARIZATION IN BACKWARD-ANGLE π^+p ELASTIC SCATTERING BETWEEN 2.50 AND 3.75 GeV/c. Sherden, D. J. (Univ. of Chicago); Booth, N. E.; Conforto, G.; Esterling, R. J.; Parry, J.; Scheid, J.; Yokosawa, A. Phys. Rev. Lett.; 25: 898-901(28 Sep 1970).

The polarization in π^+p elastic scattering in the backward hemisphere was measured at 2.50, 2.75, 2.93, 3.25, and 3.75 GeV/c. The data cover a range u of -0.5 to $+0.1$ $(GeV/c)^2$ and show a positive peak at approximately the same c.m. angle as the minimum in the differential cross section. At angles farther away from 180° the polarization becomes negative. The data are not well explained by either resonance or Regge pole models. (auth)

Particle Interactions and Properties (Theoretical)

Refer also to abstract 47533.

General

47388 SOME REMARKS ABOUT THE NO-INTERACTION THEOREM FOR RELATIVISTIC DYNAMICAL SYSTEMS. Cordesse, A. (College de France, Paris). Lett. Nuovo Cim.; 4: 226-8(1 Aug 1970).

The no-interaction theorem, which shows that only free particles may be described by an Hamiltonian formalism, is studied. It is shown that in the case of a two-particle system this is not always true. It is found that the accelerations of the first particle depend on the position of the second one and conversely. This clearly shows that in such a model some interactions between the two particles do occur. (J.F.P.)

47389 STRUCTURE OF THE STATE SPACE IN A CONVERGENT RELATIVISTIC MODEL THEORY OF INTERACTING PARTICLES. Kita, Hideji (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 1364-85(May 1970).

The structure of the state space of a model system of interacting particles is investigated from the viewpoint of the Lorentz transformations. The model system is one of two examples which have been previously obtained without use of the Lagrangian method as direct solutions of the set of the fundamental commutator equations for the ten generators (P_μ, $M_{\rho\sigma}$) of the Poincare group. The investigation is focused on the one-particle and the two-particle sectors. The unitary S matrix with the correct transformation property is obtained in a closed form. (L.B.S.)

47390 MASS DEPENDENCE OF SLOPES IN DIFFERENTIAL CROSS SECTIONS AS A PROPERTY OF MODELS FOR PRODUCTION PROCESSES. Pokorski, S. (Warsaw Univ.); Szeptycka, M.; Zieminski, A. Nuovo Cim.; 69A: 290-6(21 Sep 1970).

Possible factors responsible for the observed mass dependence of slopes in differential cross sections for three-body processes are discussed. Their role is illustrated under some model assumptions with special attention paid to the Bardakçi–Ruegg dual amplitude. (auth)

47391 REMARKS ABOUT GENERALIZATIONS OF DYNAMICAL SYSTEMS. Droz-Vincent, Ph. (Institut Henri Poincare, Paris). Lett. Nuovo Cim.; 4: 502-4(12 Sep 1970).

Abstract generalizations of dynamical systems whose interactions exhibit hereditary features are considered. In particular, the case of two relativistic particles undergoing an interaction of the retarded type, this interaction starting on some given initial spacelike hyperface Σ (switched hereditary system), is discussed. (L.B.S.)

47392 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 16, 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 68p.

47393 HIGH ENERGY PHYSICS INDEX. VOLUME 7, 1969. Author Index, Preprint, and Report Number Index. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1969). 377p.

47394 HIGH ENERGY PHYSICS INDEX. VOLUME 8, NO. 17, 1970. Frankfurt am Main; Zentralstelle fuer Atomkernenergie-Dokumentation (1970). 59p.

47395 EXACT STATISTICAL MODEL IN ONE DIMENSION. Marchioro, C.; Presutti, E. (Univ., Rome). Lett. Nuovo Cim.; 4: 488-90(12 Sep 1970).

The results of a new many-body model recently solved by Calogero are used to study the thermodynamics of the one-dimensional gas of particles interacting pairwise via an inversely quadratic potential, enclosed in a box, represented by an elastic force. In particular, the limit of vanishing external potential is discussed; it is shown that in this limit (for temperature and chemical potential fixed) the average volume effectively occupied by the gas and the logarithm of the grand partition function are linearly depending on the inverse elastic constant. It is shown that the system does not exhibit any phase transition and behavior like a perfect gas in the limit of low densities and high temperatures. (L.B.S.)

Electromagnetic

Refer also to abstracts 47452, 47507, and 47526.

47396 (JINR-P1-5178) ON THE PROTON FORMFACTORS. Bilen'kaya, S. I.; Kazarinov, Yu. M.; Lapidus, L. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1970. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

All the experimental data (published by May 1970) on the dif-

ferential cross sections of the proton-electron scattering in the range of transmitted pulse $0.3 \leq q^2 \leq 225\ F^{-2}$ were analyzed for determination of the proton formfactors and radius. Different forms of the formfactor dependence on q^2 are considered. As a result the parameter values leading to the best description of the experimental data in different ranges of q^2 are obtained. It is shown that it is impossible to obtain statistically satisfactory description of all the available data (in the range $0.3 \leq q^2 \leq 225\ F^{-2}$) for considered forms of the formfactor parametrization. The data of different groups can be coordinated only by renormalization taking into account possible systematic errors. Their satisfactory description can be obtained only at $q^2 \leq 30\ F^{-2}$. (auth)

47397 (LNF-70/34) GEOMETRICAL INTERPRETATION OF THE SCALE INVARIANCE. Ferrara, S.; Rossi, G. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 16 Jul 1970. 6p. Dep. CFSTI (U. S. Sales Only).

The scaling law for structure functions for the inelastic form factors, which is experimentally observed in inelastic e + p scattering is discussed. A possible geometrical interpretation of this law is given starting from the observation that an external Lorentz group acts in a natural way on the functions of two complex variables leading to the same consequences. (J.F.P.)

47398 MODELS FOR PARTICLES. MacGregor, M. H. (Univ. of California, Livermore). Lett. Nuovo Cim.; 4: 211-14 (1 Aug 1970).

A model for the electron is presented. In this model the mechanical properties are attributed to an ordinary mass, and the electromagnetic properties arise from a surface charge distribution. (J.F.P.)

47399 SUM RULE FOR AXIAL-VECTOR FORM FACTOR AND THE MASS OF THE AXIAL-VECTOR MESON. Fayyazuddin; Riazuddin (Univ. of Islamabad, Rawalpindi, Pakistan). Lett. Nuovo Cim.; 4: 187-92(1 Aug 1970).

The partial conservation of the axial-vector current and the current commutation relations imply a relation among the axial-vector form factor, an invariant amplitude for pion electroproduction, and the Dirac form factor. This gives a sum rule which is studied. T-channel singularities to simulate the axial vector meson pole in a given form factor are considered. (J.F.P.)

47400 NEW EXACT SOLUTIONS OF THE DIRAC EQUATION. Lam, L. (Columbia Univ., New York). Can. J. Phys.; 48: 1935-7(15 Aug 1970).

Exact solutions of a Dirac electron in constant crossed electric and magnetic fields are found and given explicitly. The case of Klein-Gordon particles is shown to be a special case. (auth) (Canada)

47401 PHOTO-PRODUCTION OF POSITIVE PIONS FROM ^{16}O. Myhrer, Fred. Phys. Norv.; No. 3, 191-4(1969).

The cross section for the reaction $^{16}O(\gamma, \pi^+)\ ^{16}N$ is computed in the region around the $(3/2, 3/2)$ resonance in the pion-nucleon system. The calculations are based upon the disperson methods developed by Shapiro and collaborators. (auth)

47402 MODEL FOR e^-e^+ ANNIHILATION AT HIGH ENERGY. Chang, Shau-jin; Fishbane, Paul M. (Univ. of Illinois, Urbana). Phys. Rev., D; 2: 1173-8(15 Sep 1970).

e^+e^- annihilation into hadrons was studied in a neutral pseudoscalar theory at high c.m. energy $\sqrt{s}$. The results are the continuation of ep inelastic scattering studied earlier. In particular, all distribution properties can be obtained from our calculation of ep inelastic scattering through the substitution $q^2 \to s$, where q is the lepton momentum transfer. Scale invariance may hold if none of the final hadron momenta are measured. However, it certainly fails if any of the hadron moments are fixed. As in ep inelastic scattering, the hadrons in the annihilation process fall naturally into two jets. The longitudinal impact parameter space is realized in each of the jets when hadron momenta are measured. (auth)

47403 COMPOSITENESS OF EXTERNAL PARTICLE AND ABSENCE OF FIXED POLES IN PHOTOPRODUCTION PROCESSES. Lee, S. Y. (Univ. of California, Los Angeles). Phys. Rev., D; 2: 1164-7(15 Sep 1970).

A new argument, based on the study of the potential-theory model, is presented which claims that the right-signature fixed poles are absent in the photoproduction processes if the external particles lie on Regge trajectories. The result is in complete agreement with the conclusions of other authors who have studied relativistic models of photoproduction. (auth)

47404 WAVE FUNCTIONS AND FORM FACTORS FOR RELATIVISTIC COMPOSITE PARTICLES. II. Licht, Arthur Lewis; Pagnamenta, Antonio (Univ. of Illinois, Chicago). Phys. Rev., D; 2: 1156-60(15 Sep 1970).

The relativistic description of composite particles is extended to the case of clusters of spin-$1/2$ particles. From this, explicit expressions for the nucleon vector current form factors are derived. It is found that the nucleon's electric form factor has the form $G^E(t) = \alpha^{-1}S_0(-t/\alpha)\sum_{i=1}^{3} q^i G_{1b}{}^1(t)$, where S_0 is the nonrelativistic form factor, $\alpha = 1 - t/4M^2$, and q^i is the charge and $G_{1b}{}^1(t)$ the electric form factor for the ith quark. A similar expression is obtained for the magnetic form factor. (auth)

47405 COMPTON SCATTERING AND THE BJORKEN LIMIT. Koegerler, R. (Univ., Vienna). Acta Phys. Austr.; 30: 346-55(1969).

In computing the unequal-time-commutator of electromagnetic currents which appear in the nucleon-photon-scattering matrix element, Bjorken's method is used to reduce this commutator to an axial vector current. A connection between the total Compton cross section and the axial vector current form factors is derived which could serve for a better computation of these form factors. Schwinger terms are calculated carefully. (auth)

47406 WAVE FUNCTIONS AND FORM FACTORS FOR RELATIVISTIC COMPOSITE PARTICLES. I. Licht, Arthur Lewis; Pagnamenta, Antonio (Univ. of Illinois, Chicago). Phys. Rev., D; 2: 1150-6(15 Sep 1970).

A relativistic description is given of composite particles which behave as nonrelativistic clusters in their rest frames. It is found that the relativistic form factor can be obtained from the nonrelativistic one by the substitution $S(t) = \alpha^{(1-n)/2}S_0(|t|/\alpha)$, where $\alpha = 1 - t/(4M_\Lambda^2)$, and where n is the number of subparticles in the cluster. An excellent one-parameter fit to the magnetic form factor of the proton is found. (auth)

47407 HIGH-ENERGY DEEP-INELASTIC ELECTRON-NUCLEON SCATTERING IN A RENORMALIZABLE THEORY. Chang, Shau-jin; Fishbane, Paul M. (Univ. of Illinois, Urbana). Contract NSF GP-8081. Phys. Rev., D; 2: 1084-1103(15 Sep 1970).

High-energy deep-inelastic electron-nucleon scattering was studied in a neutral pseudoscalar-meson theory by summing an infinite set of diagrams. The diagrams analyzed are straight ladder unitary diagrams, with pions as the rungs. Explicit lower-order calculations indicate that this set of diagrams gives the leading ln $|q^2|$ contribution, where q^2 is the momentum transfer squared, provided that nucleon-antinucleon pair creations and nucleon vertex corrections are ignored. The main results are: (1)The final hadrons fall naturally into two jets; (2) the Bjorken scaling law breaks down; (3) the number of pions increases as ln $|q^2|$; and (4) a longitudinal impact-parameter space is realized. Some possible experimental consequences are deduced. (auth)

47408 SIXTH ORDER RADIATIVE CORRECTION TO THE DIFFERENCE OF THE ANOMALOUS MAGNETIC MOMENTS OF MUON AND ELECTRON. Lautrup, B. (CERN, Geneva). Phys. Lett.; 32B: 627-30(31 Aug 1970).

The completion of the calculation of the sixth order contribution to the difference of the anomalous magnetic moments of muon and electron is reported. The new theoretical value of the anomalous magnetic moment of the muon is $(1\ 165\ 848 \pm 46) \times 10^{-9}$ in reasonable agreement with experiment. (auth)

47409 REGGE POLE MODEL WITH DIFFRACTIVE CORRECTION. IV. THE PION PHOTOPRODUCTION. Biyajima, Minoru; Kenmoku, Masakatsu (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto); 43: 1255-62(May 1970).

A considerable amount of data on the forward π^0(in detail) and $\pi^+(\pi^-)$ photoproduction is analyzed in terms of the Regge pole model with the diffractive correction. The results agree qualitatively well with the differential cross section $[(s - m^2)^2 d\sigma/dt(\gamma p \to \pi^0 p)]$ and the π^0 photoproduction asymmetry with polarized photon (at 3.4 GeV). Further the ratio of $d\sigma/dt(\gamma p \to \pi^0 p)/d\sigma/dt(\gamma n \to \pi^0 n)$ and the recoil nucleon polarization p(t) and the polarized target asymmetry T(t) are predicted. (auth)

47410 ASYMPTOTIC RELATIONS AMONG VECTOR AND AXIAL VECTOR FORM FACTORS OF THE Σ-BARYON. Abdel-Rahman, A.-M. M. (Univ. of Liverpool). Lett. Nuovo Cim.; 4: 495-501(12 Sep 1970).

A mass extrapolation procedure is used to obtain asymptotic relations among the form factors of the Σ-baryon. The results are similar to those previously obtained for the nucleon. It is noted that similar relations hold for the Ξ form factors. (L.B.S.)

47411 TWO-PHOTON DECAYS OF MESONS. Rechenberg, H.; van der Merwe, P. du T. (Max-Planck-Institut fuer Physik

und Astrophysik, Munich). Nuovo Cim.; 69A: 192-206(21 Sep 1970).

An attempt is made to describe the radiative decays of pseudoscalar mesons in the framework of the nonlinear spinor theory. In a first approximation reasonable decay widths can be calculated for the neutral pion and the η-meson. (auth)

47412 ELECTROMAGNETIC FORM-FACTOR EFFECTS IN PION DECAY. Bailin, A.; Bailin, D. (Univ. of Sussex, Brighton, Eng.). Nuovo Cim.; 69A: 207-30(21 Sep 1970).

An attempt is made to include the effects of strong interactions on the electromagnetic corrections to π_{l_3} by following Källén's program for the first few intermediate states. The approach differs from Källén's in that it is fully gauge invariant. As a result it is found that the contribution from each individual state is divergent and has to be cut off. However, there is extensive cancellation when these contributions are combined and a finite cut-off-independent value is found for the branching ratio of the two decay modes, which differs in a significant way from the usual form. (auth)

47413 COMMUTATORS OF CURRENT DENSITY OPERATORS: ASYMPTOTIC EXPANSION WITH THE PHOTON MASS TENDING TO INFINITY. Ruehl, W. (CERN, Geneva). Nuovo Cim.; 69A: 231-8(21 Sep 1970).

After a simple change of co-ordinates one can perform an $O_{3,1}$ analysis for which the ratio of photon mass squared to photon energy in the rest system of the proton is fixed. Identifying the poles of the Fourier transforms with Lorentz poles leads to a model in which the photon picks up part of the proton and scatters off the remainder of the proton by Lorentz-pole exchange. Different Lorentz poles are linked together by current conservation. It is predicted that the ratio $\sigma_1:\sigma_t$ tends to zero at infinity. (auth)

47414 PCAC, THE DALITZ-PAIR PROCESS AND THE PRIMAKOFF EFFECT IN THE PHOTOPRODUCTION OF A_1^0 ON PROTON. Chang, T. H. (Univ. of Chicago). Contract AT(11-1)-264. Nuovo Cim.; 69A: 239-60(21 Sep 1970).

The PCAC condition is applied to the Dalitz-pair process and its consequences are compared with the ordinary phenomenological Lagrangian method, and Adler's perturbation method in which the triangular diagram is essential for the $\pi^0\gamma\gamma$ vertex. Next the Primakoff effect in the photoproduction of the axial-vector meson A_1^0 on a proton is calculated explicitly. The coupling strength of the $A_1^0\gamma\gamma$ vertex is estimated from the hyperfine splitting in the hydrogen atom, but it turns out to be an order of magnitude smaller than the value determined from the $\pi^0\gamma\gamma$ vertex indirectly through PCAC. (auth)

Weak

Refer also to abstracts 46904 and 47488.

47415 (LNF-70/27) ADLER'S NEUTRINO SUM RULES IN THE SCALING LIMIT AND THE POSSIBILITY OF A CHIRAL POMERON. Note No. 482. Etim, E. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 26 Jun 1970. 8p. Dep. CFSTI (U. S. Sales Only).

The prediction that the ratio of neutrino–to antineutrino–nucleon total and differential cross sections with respect to the Bjorken variable is 3 to 1 is discussed. While previously it was argued that either the Pomeron is chiral or the Adler neutrino sum rules are trivially satisfied or badly violated, it is shown that this 3 to 1 ratio can be accommodated in a diffractive model of scaling. Thus it can be in no way implied that the Pomeron is chiral. (J.F.P.)

47416 (SINP-TH-67-10) SUPPRESSION OF STRANGENESS-CHANGING LEPTONIC DECAYS OF HADRONS. Pradhan, T.; Patnaik, M. (Saha Inst. of Nuclear Physics, Calcutta (India)). 15 Apr 1967. 9p. Dep. CFSTI (U. S. Sales Only).

It is shown that a fairly satisfactory explanation of the suppression of $\Delta S = 1$ coupling relative to the $\Delta S = 0$ coupling for hadron leptonic decays can be given in the framework of universal Fermi interaction by making simple assumptions about the weak hadron currents. (L.B.S.)

47417 μ-e RATIO FOR SEMI-LEPTONIC HYPERON DECAYS. Pietschmann, H. (Inst. of Theoretical Physics, Goteborg. Univ., Vienna); Streeruwitz, E. Acta Phys. Austr.; 29: 362-4 (1969).

The μ-e ratio for semi-leptonic hyperon decays is computed for all 5 types of interaction (S, V, T, A, P). It is shown, that because of the presence of Fierz interference terms, the μ-e ratio allows for an experimental limit of possible S, P, and T admixtures to the V-A interaction with $|\Delta Y| = 1$. (auth)

47418 SOME CONSEQUENCES OF V–A. Zingl, Harald F. K. (Univ., Munich). Acta Phys. Austr.; 29: 384-6(1969).

The connections between the Pauli-Fierz reordering theorem in V-A theory with graphs from an intermediate vector boson theory are illustrated for the case of $\mu^- \rightarrow e^- + \bar{\nu}_e + \nu_\mu$ decay. (L.B.S.)

47419 DECAY $\pi^- \rightarrow \pi^0 + e^- + \bar{\nu} + \gamma$ WITH AXIAL VECTOR COUPLING. Faustmann, H. J.; Urban, P. (Univ., Graz). Acta Phys. Austr.; 30: 380-92(1969). (In German).

The axial vector part of the radiative $\pi - \beta$ decay is considered and its structure functions are calculated by means of dispersion relations assuming a dominant ρ meson pole and taking for its matrix element an explicit form given in the literature. An application of PCAC then leads to a simple relation (which can be tested by experiment) between the $\gamma - 3\pi$ coupling constant, the $\rho\pi\gamma$ coupling constant, and the pion decay constant. (auth)

47420 NOTE ON A THEOREM ON THE K_{l3} FORM FACTORS. Korthals Altes, C. P. (Oxford Univ.). Phys. Rev., D; 2: 1181-4 (15 Sep 1970).

A simple method is proposed to derive a theorem due to Dashen and Weinstein. The only assumptions involved are the vector–axial-vector charge commutators. (auth)

47421 COMMENTS ON RADIATIVE K_{e3} DECAYS. Doncel, M. G. (CERN, Geneva). Phys. Lett.; 32B: 623-6(31 Aug 1970).

Calculations of the radiative K_{e3} branching ratios were performed with cuts in the photon energy as well as in the electron photon angle as imposed by the experimental set-up. Good agreement was found with preliminary experimental results. (auth)

47422 MAGNITUDE AND SIGN OF THE K_1-K_2 MASS DIFFERENCE. Engler, Arnold (Carnegie-Mellon Univ., Pittsburgh). Progr. Nucl. Phys.; 11: 271-309(1970).

The survey presented indicates the satisfactory experimental status of studies on the K_1-K_2 mass difference. The evidence that K_1 is heavier than K_2 comes from two conclusive experiments, and a third experiment provides good corroboration. As regards the magnitude of the mass difference, agreement amongst recent experiments is gratifying. An important conclusion is that there is no evidence for any difference in the value of Δm as obtained by the various methods of measurement. The theoretical aspect of the problem, however, is not very clear. Although numerous calculations have been made they cannot be regarded as very reliable since the difference between two self-energy integral is involved. Considerably more work is required before arriving at a theoretical status comparable to the experimental status. Headings are as follows: Introduction; methods for determining magnitude and sign of Δm (strangeness oscillations, regeneration); experimental results (strangeness oscillations, regeneration experiments, CP violation experiments, experiments on the sign of Δm). (55 references) (UK)

47423 INTERACTION OF NEUTRINOS WITH NUCLEI AT HIGH ENERGIES. Ryskin, M. G. (Ioffe Inst. of Physics and Tech., Leningrad). JETP Lett. (USSR) (Engl. Transl.); 11: 416-18(20 Jun 1970).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Red.; 11: 600-3 (20 Jun 1970).

The interaction between high-energy neutrinos and nuclei is considered assuming that large distances are involved in the integral for the amplitude of the forward Compton effect. It is shown that in spite of the allowance for strong interactions, the total cross section for the absorption of a neutrino by a nucleus does not increase faster than the first power of the energy. The cross section obtained is proportional to the number of nucleons on the surface of the nucleus. (J.F.P.)

47424 MODEL OF PARITY-VIOLATING NONLEPTONIC DECAYS. Nishijima, Kazuhiko; Sato, Hikaru (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1316-29(May 1970).

On the basis of the field-current identity and the universal current–current interaction a divergence-free model of parity-violating nonleptonic decays is constructed. Octet enhancement is a natural consequence of this model and the decay amplitudes are evaluated without introducing any arbitrary parameter. The theoretical results show an excellent agreement with the corresponding experimental ones. These results render a support for the current–current picture of nonleptonic decays. (auth)

Strong (General)

47425 (SINP-TH-67-21) WEAK AXIAL VECTOR COUPLING CONSTANT IN THE STATIC CHEW–LOW MODEL. Pradhan, T.; Pattnaik, M. (Saha Inst. of Nuclear Physics, Calcutta (India).

Theoretical Nuclear Physics Div.). [1967]. 10p. Dep. CFSTI (U. S. Sales Only).

By properly defining weak currents so as to include the mesonic contributions and thereby have them satisfy the chiral SU(2) ⊗ SU(2) algebra, it is shown that the axial vector coupling constant is renormalized by a factor $|G_A/G_V| = 1.13$ due to static pion-nucleon interaction $H = (f_0/\mu)\,\zeta_\alpha\,\bar{\sigma}\cdot\bar{\nabla}\phi_\alpha$. It is also shown that $1 \le (G_A/G_V)^2 \le 3/2$ in this model. (auth)

47426 ODD-SIGNATURE TRAJECTORIES, SERPUKOV TOTAL-CROSS-SECTION DATA, AND THE POMERANCHUK THEOREM. Arnowitt, R.; Rotelli, P. (Imperial Coll. of Science and Tech., London). Lett. Nuovo Cim.; 4: 179-86 (1 Aug 1970).

The question of whether the total Brookhaven and Serpukhov data can be fitted using only Regge poles is examined. In addition to the usual Regge poles there are included in the phenomenological analysis an I = 0 odd-signature Pomeron-like object P_0 and an I = 1 odd-signature P_1 to account for possible breakdowns of the Pomeranchuk theorem. (J.F.P.)

47427 DYNAMICS OF A DOUBLE-PEAKED RESONANCE. Campbell, R. Russell; Coulter, Philip W.; Shaw, Gordon L. (Univ. of California, Irvine). Phys. Rev., D; 2: 1184-6(15 Sep 1970).

Evidence is presented that a double-peaked resonance implies two nearby poles of the S matrix rather than the interference of the resonance with a background where singularities are relatively far away. (auth)

47428 IMPLICATIONS OF CERTAIN ALGEBRAIC ASPECTS OF DUAL RESONANCE MODELS. Galli, Alicia; Galli, Eduardo (Yeshiva Univ., New York). Phys. Rev., D; 2: 1081-3(15 Sep 1970).

Certain algebraic aspects present in the dual resonance models led Susskind and Frye to the construction of n-point pion amplitudes in the tree-graph approximation which are a sum of terms, each one coming from a distinct permutation and satisfying the Adler's condition separately. It was shown that this line of reasoning picks up a definite form of chiral symmetry breaking (in SU2 ⊗ SU2). It is shown that the extension to the pseudoscalar multiplet forces one to include the whole nonet. The resulting amplitudes coincide with those obtained from an U(3) ⊗ U(3) model with the chiral symmetry broken in a way that preserves the complete nonet degeneracy. (auth)

47429 BJORKEN LIMIT IN A MODEL THEORY. Fukuda, Reijiro (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1330-3(May 1970).

Using a model theory, it is pointed out that the Bjorken limit of the renormalized amplitude is related to the divergence of the renormalization constant. In order that the Bjorken limit is valid in general, even the removable divergences must not occur. (auth)

47430 CONSTANT DIFFERENCES AMONG TOTAL CROSS SECTIONS AND A NEW POMERANCHON. Shiga, Kunio; Uehara, Masayuki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 1404-6(May 1970).

The possibility of breakdown of the Pomeranchuk theorem and the asymptotic behavior of scattering amplitude is discussed on the basis of urbaryon rearrangement diagrams for hadron processes. (L.B.S.)

47431 MULTIPLICITY IN HIGH-ENERGY HADRONIC COLLISIONS. Mori, Kenju; Nakamura, Hiroshi (Saitama Univ., Japan. Aoyama Gakuin Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 43: 1213-23(May 1970).

The multiplicity in high hadronic collisions is calculated on the basis of the H-quantum theory. (auth)

47432 COMPARISON WITH EXPERIMENTAL EVIDENCE OF THE AMATI–STANGHELLINI–FUBINI MULTIPERIPHERAL MODEL. La Camera, M.; Bartolucci, M.; Wataghin, A. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Lett. Nuovo Cim.; 4: 507-11(12 Sep 1970).

Detailed calculations are given of the behavior of scattering amplitudes in the Amati–Stanghellini–Fubini multiperipheral model to see if the model well describes the outstanding experimental features of the multiple production in high energy physics. (L.B.S.)

47433 PROBLEMS WITH CURRENTS IN THE DUAL-RESONANCE MODEL. Hasslacher, B.; Sinclair, D. K. (State Univ. of New York, Stony Brook). Contract AT(30-1)-3668B. Lett. Nuovo Cim.; 4: 515-9(12 Sep 1970).

Several attempts have been made to construct physically satisfactory dual conserved currents within the generalized Veneziano model. Comments are made on some relations among the models which may show both their structure and their problems. (L.B.S.)

47434 Y*(1385) PRODUCTION IN MULTIBODY FINAL STATES AND THE QUARK MODEL. Gizbert-Studnicki, P.; Golemo, A. (Jagellonian Univ., Krakow). Lett. Nuovo Cim.; 4: 473-4(12 Sep 1970).

Quark-model predictions are presented for the decay distribution of $\frac{3}{2}^+$ isobar produced in the reaction $0^- + \frac{1}{2}^+ \to A + \frac{3}{2}^+$ and $\frac{1}{2}^+ + \frac{1}{2}^+ \to A + \frac{3}{2}^+$, where A is the final state with any number of particles and the initial particles are assumed to be unpolarized. It is shown that the measurement of the polarization of the Y*(1385) resonance produced in multibody reactions at small momentum transfer provides a strong and qualitatively new test of the additivity assumption. (L.B.S.)

Strong (Baryon No. = 0)

Refer also to abstract 47490.

47435 VENEZIANO MODEL AND THE FINITE ENERGY SUM RULES. Vasavada, K. V. (Univ. of Connecticut, Storrs). Can. J. Phys.; 48: 1879-81(15 Aug 1970).

The left-hand side of the finite energy sum rules for the Veneziano amplitude is summed explicitly. This shows that, for sufficiently large cutoff, the finite energy sum rules are satisfied with the leading contribution only. The actual sum contains other nonleading contributions. (auth) (Canada)

47436 CROSSING-SYMMETRY SUM RULES APPLIED TO BROWN AND GOBLE'S MODEL FOR $\pi\pi$ SCATTERING. Krinsky, Samuel (Yale Univ., New Haven). Contract AT(30-1)-2726. Phys. Rev., D; 2: 1168-73(15 Sep 1970).

The sum rules of Roskies are used to introduce constraints following from crossing symmetry into Brown and Goble's model for low-energy pion-pion scattering. The S and P waves are parametrized in a way consistent with elastic unitarity. Brown and Goble's P wave, which exhibits a ρ meson at 750 MeV of width 115 MeV is not modified. A total of five parameters is introduced into the S waves; these are fixed in a well-defined way by the five sum rules relating the S and P waves. The resulting isospin-O S-wave phase shift passes through 90° at 800 MeV. The isospin-2 S-wave phase shift is small and negative. The S-wave scattering lengths are determined to be $a_0^0 = 0.105 m_\pi^{-1}$ and $a_0^2 = -0.051 m_\pi^{-1}$. The $\pi^0\pi^0$ amplitude satisfies Martin's inequalities, which follow from crossing symmetry and the positivity of the crossed-channel absorptive part. (auth)

47437 CONFORMAL-INVARIANT π^0–π^0 SCATTERING. Castell, L. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Phys. Rev., D; 2: 1161-3(15 Sep 1970).

The asymptotic high-energy behavior of the elastic scattering amplitude for two spin-0 particles for fixed angle ϑ ($\vartheta \neq 0^0$, $\vartheta \neq 180°$) is calculated from the condition of conformal invariance. For elastic π^0-π^0 scattering the differential cross section $d\sigma/d\Omega \approx (1/s)(m^2/s)^{12}F(\cos\vartheta)$ is obtained. The π^0 is assigned to an irreducible representation of the conformal group with continuous mass spectrum. (auth)

47438 REST-FRAME SUM RULES FROM QUARK MODEL AND FIELD ALGEBRA. Komen, G. J. (International Centre for Theoretical Physics, Trieste, Italy); Pallua, S. Phys. Rev., D; 2: 989-99(15 Sep 1970).

The extrapolation of low-energy theorems for certain weak quantities from the soft point to the ρ mass is studied. A parabola in the plane of variables, essentially connected with the mass and energy of the particles involved, is taken for the path of extrapolation, as proposed by Fubini and Furlan. As a consequence, sum rules involving the $\pi\rho$ and ρN elastic scattering matrices at threshold are obtained, in which the most important contributions are explicitly exhibited. An important term arises from the right-hand side of the equal-time commutation relation of space components of vector currents, and thus the resulting sum rules are particularly suitable for discussing models which predict such commutators. The same results are obtained in the saturation approach, starting from commutators of electric dipoles and space–space commutators of vector currents. Combining the $\rho\pi$ scattering matrix sum rule with the Weinberg formula, an expression for $\frac{1}{6}\langle r_\pi^2\rangle$ is found. In this particular case and under the simplest assumptions, both field algebra and quark model are compatible with the data within present experimental errors. The investigation is extended to the algebra of tensor currents and together with a hypothesis of partial conservation of tensor current and local SU(2) algebra, this leads to a value for the difference of the mean-square electromagnetic pion and nucleon radius as an exact consequence. (auth)

47439 A_2 MESON AS AN O(4) FAMILY. Chang, Ngee-pong; Nelson, Charles A. (City Coll., New York). Phys. Rev., D; 2: 966-73(15 Sep 1970).

The possibility that the A_2 meson represents an O(4) n = 2, M = 0 family with the spin content 2^{++}, 1^{-+}, 0^{++} (J^{PC}) is investigated. The spin-parity of the lower $\pi\rho$ peak has not been firmly established, although current evidence favors a 2^+ assignment. Sufficient motivation is given by the linearity of trajectories and by the dual-resonance model to entertain the possibility of a 1^- assignment and to study its consequences. A new element in the phenomenology of the O(4) resonance system is the importance of the production mechanism, since not all members of the family will be produced equally in all reactions. By using the Blankenbecler-Sugar form of Regge exchange together with an "O(4)" field introduced in the preceding paper, a simple understanding of the production mechanisms is proposed. Thus predictions can be made for the apparent widths and spin-parity content of resonances produced in various channels. One interesting feature of the model is that the $K^{**} \to K\pi$ width as seen in a π^-p experiment should be narrower than the $K^{**} \to K\pi$ width as seen in a K^+p experiment. $\Gamma^H = 23$ and $\Gamma^L = 20$ are predicted for the $A^H(2^+)$ and $A^L(1^-)$ in the $\pi\rho$ system by a finite-energy sum rule corresponding to isospin 1 and double helicity flip in the t channel. Also, the SU(3) predictions for the true decay widths of each member of the O(4) family are given. Because the dual-resonance model would also predict the production of excited states belonging to O(4), some mock calculations are made in the model for comparison with the usual Regge phenomenology. (auth)

47440 ISOSCALAR S-WAVE $\pi\pi$ PHASE SHIFT FROM A UNITARY CURRENT-ALGEBRA MODEL. Nutbrown, D. A. (Univ. of Rochester, N. Y.). Phys. Rev., D; 2: 1140-6(15 Sep 1970).

Using the equal-time commutation relations of chiral SU(2) × SU(2), a Ward identity relating the vertex fraction $\langle\pi|\sigma|\pi\rangle$ to the σ propagator is derived. Adopting a model for the primitive three-point function of two axial-vector currents and an isoscalar σ operator, an integral equation for the vertex function is derived by inserting elastic unitarity into the identity. In the approximation of neglecting inelastic effects, the integral equation is solved exactly. The solution contains three arbitrary constants which are fixed from current-algebra and partially conserved axial-vector current considerations. An isoscalar, S-wave π-π phase shift is then obtained, which is positive and rises to 180° at infinity. Moreover, it corresponds to a scattering length a_0 just 5% larger than Weinberg's and, together with the ρ and f contributions, saturates the π-π Adler–Weisberger relation to within 10%. Finally, $m_\rho = 725 \pm 55$ MeV and $\Gamma_{\rho\to\pi\pi} = 455 \pm 55$ MeV are predicted. (auth)

47441 DUALITY AND THE $\pi-\eta$ DEGENERACY. Canning, G. P. (Tel-Aviv Univ., Israel). Phys. Rev., D; 2: 1146-9 (15 Sep 1970).

In the context of duality and the absence of exotic resonances, the question of the $\pi-\eta$ degeneracy is discussed. This is crucial for an understanding of the internal symmetry incorporated in the meson spectrum. The situation is examined where the π is exchange degenerate with A_1 and not B, which is in accord with experiment. The η should not then be degenerate with the π. Nevertheless, an inconsistency is demonstrable when factorization constraints are applied to the leading trajectory couplings in PV → PV meson reactions. This follows from an assumption of SU(2) only, not SU(3). The inconsistency is removed by assuming degenerate doubling of the particles on the A_1 and D trajectories. (auth)

47442 K_{13}, K_{14} FORM FACTORS AND ADLER–WEISBERGER SUM RULES FOR THE πK AMPLITUDES IN THE VENEZIANO MODEL. Kurokawa, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto); 43: 1406-7(May 1970).

It is shown that the Adler–Weisberger type sum rules with the Veneziano-type πK amplitudes give reasonable results for the K_{13} and K_{14} form factors. The results are consistent with both experiments and current algebra. (L.B.S.)

47443 EXCHANGE OF TWO URBARYON–ANTIURBARYON PAIRS IN BARYON–ANTIBARYON PROCESSES. Yoshida, Toshihiro (Kyoto Univ.). Progr. Theor. Phys. (Kyoto); 43: 1307-15(May 1970).

Duality between direct channel resonances and exchange of two Regge poles in baryon–antibaryon (and baryon–baryon) process is investigated based on the simplest composite model. Two kinds of degeneracy are found between Regge poles (both their trajectories and couplings at t = 0), i.e, exchange degeneracy and "doublet" degeneracy. (auth)

47444 MODEL OF MULTIPLE MESON PRODUCTION AT ULTRAHIGH ENERGIES. Fujiwara, Katsuaki; Kitazoe, Tetsuro (Kobe Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 1244-54(May 1970).

A model of multiple meson production in the collisions of elementary particles at very high energies is proposed. It is assumed that the system of particles produced in a collision cannot be in an equilibrium state; this is in contrast with the fireball model proposed by Fermi. In order to formulate the non-equilibrium state, the stochastic description is employed for the collision process, in which particles are created with a certain probability during a collision. When this model is applied to $\pi-\pi$, $\pi-N$ and $N-N$ collisions, the multiplicities of the particles produced in the collisions and the standard deviations in the multiplicity distributions are expressed by two parameters, one of which can be eliminated if the Regge pole model is used for the elastic scattering cross sections. The log-type slow increase of the multiplicities with incident energies is obtained, giving a fair agreement with experiment for both $\pi-N$ and $N-N$ collisions. Large standard deviations in the multiplicity distributions compared with the equilibrium case are obtained in consistency with experiment. (auth)

47445 WEINBERG SUM RULES WITH VENEZIANO RESIDUES. Oyanagi, Yoshio (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1408-9(May 1970).

An expression was recently proposed for the pion electric form factor $F_\pi(t)$ based on the Veneziano-type scattering amplitudes combined with the field-current identity, PCAC, and current algebra. It is shown that although the axial-vector current $A\mu$ and the vector current $V\mu$ are treated asymmetrically in this model, the result obtained still satisfies a weaker form of the chiral symmetry, i.e., it is consistent with the Weinberg sum rules. (L.B.S.)

47446 SPIN STRUCTURE OF MULTIPLE SCATTERING. Dadic, I.; Martinis, M. (Inst. Rudjer Boskovic, Zagreb). Nuovo Cim.; 69A: 175-91(21 Sep 1970).

A two-body effective optical potential is defined in terms of overlap functions, utilizing dispersion relations for phase shifts. The proposed model is based on an earlier calculation of diffraction effects using the unitarity of the S-matrix. A new method of incorporating spin properly and uniquely into multiple scattering is presented. The method is illustrated on three, from the practical point of view, most interesting spin cases: spin-½–spin-0, spin-½–spin-½ and spin-1–spin-0 scattering. The region where s is large, t finite and $|t| \ll s$ has only been considered. (auth)

Strong (Baryon No. = 1)

Refer also to abstract 47410.

47447 (CONF-690557-(Vol.2), pp 781-95) MESON–BARYON COUPLINGS AND K^-p REACTIONS. Das Gupta, S.; Mohana, B. K.; Mitra, A. N. (Delhi Univ. (India). Dept. of Physics and Astrophysics).

A phenomenological model of meson–baryon couplings based on a quark model with broken SU(6) × O(3) proposed recently is used for the calculation of certain K^-p reactions via the s-channel, with the inclusion of baryon resonances belonging to $(70,1^-)$ and $(56,2^+)$ supermultiplets. The results, which show fairly good agreement with the experimental data on $K^- - p$ total cross sections as well as the $\Sigma\pi$ and $\Lambda\eta$ reactions, bring out the sensitive dependence of the assumed form factors on the masses and momenta involved. (auth)

47448 (SINP-TH-67-17) LOW-ENERGY KAON–NUCLEON SCATTERING. Baba Pundari, S.; Dutta-Roy, B. (Saha Inst. of Nuclear Physics, Calcutta (India). Theoretical Nuclear Physics Div.). [nd]. 16p. Dep. CFSTI (U. S. Sales Only).

The successes of the current algebra method and the vector-meson dominance approach for s-wave kaon-nucleon scattering lengths are taken to suggest an anstz that in the absence of t-channel singularities, low energy s-wave kaon-nucleon scattering is absent. This leads to certain sum-rules which allows a determination of the kaon-baryon coupling constants which agree very well with other estimates. These values of the coupling constants are then found to give a satisfactory fit to low-energy kaon-nucleon s- and p-wave phase shifts. (auth)

47449 SCALE INVARIANCE AND CURRENT-ALGEBRA SIGMA TERMS. de Alwis, S. P.; O'Donnell, P. J. (Univ. of Toronto). Phys. Rev., D; 2: 1023-6(15 Sep 1970).

It is shown that, in a scale-invariant theory in which the vacuum does not realize the symmetry, the dominant configuration to the sigma terms arising in current-algebra determinations of the meson-baryon scattering lengths can be estimated. (auth)

47450 NONLINEAR HADRON COUPLINGS FROM DIVERGENCE CONDITIONS. I. PIONS AND NUCLEONS. Gupta, Suraj N.; Weihofen, William H. (Wayne State Univ., Detroit). Phys. Rev., D; 2: 1123-30(15 Sep 1970).

It is shown that chiral-dynamical models for the pion–nucleon system can be obtained simply by requiring that the source function in the pion field equation be expressible as a complete divergence. Both nonderivative and derivative pion–nucleon couplings are considered. The nonderivative-coupling case yields models with one coupling constant, while the derivative-coupling case leads to models involving two coupling constants. Since our approach avoids the use of chiral symmetry, it does not raise the problems associated with a broken symmetry. It is also suggested that the nonlinear pion–nucleon coupling, arising from the divergence condition, might very well represent a fundamental coupling rather than merely an effective coupling. (auth)

47451 NONLINEAR LAGRANGIAN TRANSFORMATIONS. El-Ghabaty, Sayed S.; Gupta, Suraj N.; Weihofen, William H. (Wayne State Univ., Detroit). Phys. Rev., D; 2: 1130-5(15 Sep 1970).

In nonlinear Lagrangian schemes it is useful to transform the nonderivative pion–nucleon coupling into the derivative coupling. The effect of such a transformation on renormalization constants and closed-loop diagrams is investigated by direct calculations of the second-order nucleon and pion self-energies and the fourth-order nucleon–nucleon interaction with the inclusion of the renormalization diagrams. By carefully combining the contributions of appropriate diagrams, the complete equivalence of the nonderivative and derivative couplings is demonstrated. (auth)

47452 n-p MASS DIFFERENCE IN A MODEL OF HIGHER BARYON COUPLINGS. Choudhury, D. K.; Mitra, A. N. (Univ. of Delhi). Phys. Lett.; 32B: 619-22(31 Aug 1970).

A unified model of PBB_L and VBB_L couplings recently proposed by one of us (ANM) is augmented by VDM to calculate the n-p mass difference. The $J = L - \frac{1}{2}$ states of $(56, 2^+)$ are found crucial for bringing about the correct sign and magnitude. (auth)

47453 SELF-SUSTAINING REGIME FOR REGGE TRAJECTORIES. Shirkov, D. V. (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Lett.; 32B: 635-7(31 Aug 1970).

The question of correspondence between the experimental data on baryon Regge trajectories and the spectral representation without an additional linear term is considered. The hypothesis of "self-sustaining regime" for trajectories is formulated and its consequences are discussed. The determining role of inelastic contributions to Im α is established. The hypothesis of the cascade mechanism of forming of the total resonances widths is proposed. (auth)

47454 $N^*(1236)$, $Y_1^*(1385)$, AND $Y_0^*(1405)$ CONTRIBUTIONS TO A SUM RULE FOR D/(F + D). Abdel-Rahman, A.-M. M. (Univ. of Liverpool). Progr. Theor. Phys. (Kyoto); 43: 1409-11(May 1970).

An estimate was previously given for the D/(F + D) ratio of the axial vector current in the baryon octet from a consideration of the sum rule that arises when the commutator is taken between physical Σ^- and p states. In saturating the sum rule only the contributions from baryon octet states were included. The effect on the D/(F + D) ratio of approximating the continuum with the $N^*(1236)$, $Y_1^*(1385)$ and $Y_0^*(1405)$ contributions is examined. (L.B.S.)

47455 SHORT-RANGE INTERACTION BETWEEN PION AND NUCLEON. Kanki, Takeshi; Nakatani, Hiroshi (Osaka Univ.). Progr. Theor. Phys. (Kyoto); 43: 1263-86(May 1970).

Asymptotic behaviors of the so-called force functions, dispersion integrals over left-hand cuts of partial-wave amplitudes, in pion-nucleon scattering are investigated. By virtue of the exponential decrease of fixed cos θ amplitudes for $s \to +\infty$ with $|\cos\theta| < 1$, the left-hand cut contributions to these amplitudes, from which the force function is obtained by doing the partial-wave projection, can be evaluated in terms of the right-hand cut integrals. The empirical formulas for high-energy scattering are used for evaluating these right-hand cut integrals. The two cases are considered, in which Krisch's formula and Orear's one are used for the large-angle scattering, respectively. For the case of Krisch's formula, it is found that the asymptotic behavior of πN force function for any partial wave is dominated by the contribution from a diffraction-scattering term and this contribution gives rise to an attractive short-range force, and that for the P_{11} state, this attractive force seems to be somewhat weaker than that required in the previous N/D bootstrap calculation. For the case of Orear's formula, no definite conclusion is obtained because of the possibility that large angle regions give rise to large contributions. (auth)

47456 PARTICLE EXCHANGE, REGGE POLE EXCHANGE, AND THE GENERALIZED POTENTIAL IN πN SCATTERING. Kinoshita, Kisei (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto); 43: 1287-1300(May 1970).

The generalized potentials for the πN system are formulated as functions of the (s, t, u) variables, in a form free from kinematical singularities, and their values in the resonance region are obtained from experimental phase shifts. The contributions from the N, Δ, ρ and $\epsilon(700)$ exchange as elementary particles reproduce qualitatively the generalized potentials near the threshold and in the forward direction, but they differ from the generalized potentials in the region of large momentum transfer and/or higher energy. The generalized potential can be well reproduced by multiplying the Regge-like damping factors to all the particle exchange terms and omitting the t-dependence of the residues of the Δ-exchange terms. (auth)

47457 ENERGY VARIATION OF THE SLOPES OF ELASTIC ANGULAR DISTRIBUTIONS AND DUALITY. Hama, Y.; Predazzi, E. (Univ., Sao Paulo, Brazil). Lett. Nuovo Cim.; 4: 477-82 (12 Sep 1970).

One general feature of elastic angular distributions is that the slopes in exotic channels (K^+p and pp) show an increase toward a constant, where in the case of nonexotic channels they either decrease toward a constant or seem to remain essentially constant. A brief account is given of an analysis of K^+p and K^-p interactions in order to investigate whether this property can be qualitatively understood using the Regge-pole formalism within the framework provided by duality. (L.B.S.)

47458 FINITE-ENERGY SUM RULE TEST FOR A POSSIBLE VIOLATION OF THE POMERANCHUK THEOREM. Ferrari, E. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Violini, G. Lett. Nuovo Cim.; 4: 483-712 Sep 1970).

Best fit parameters to high-energy cross-section data for KN and πN scattering are examined to investigate whether finite-energy sum rules predict a possible violation of the Pomeranchuk theorem. It is concluded that an assumption of a violation is not substantially preferred to that of a conventional Regge-pole description, and that finite-energy sum rules do not provide a support to the violation. (L.B.S.)

Strong (Baryon No. ≥ 2)

Refer also to abstracts 47365, 47372, and 47673.

47459 (CONF-690557-(Vol.1), pp 51-91) BOSON-EXCHANGE POTENTIAL MODELS FOR BARYON–BARYON INTERACTIONS. Downs, B. W. (Colorado Univ., Boulder).

Some features of the one-boson-exchange potential are discussed. The baryon–baryon–boson couplings are defined, and SU(3) relations among the couplings are given to facilitate the description of a YN model. Ambiguities in the coordinate space representations of the one-boson-exchange potential are discussed, and differences among and uncertainties in the various one-boson-exchange potentials which were used for NN and YN interactions are pointed out. (J.F.P.)

47460 (CONF-690557-(Vol.1), pp 92-158) STUDY OF Y–N AND Y–Y INTERACTIONS USING FINAL-STATE INTERACTIONS. Cline, D. (Hawaii Univ., Honolulu. Wisconsin Univ., Madison); Laumann, R.; Mapp, J. (Wisconsin Univ., Madison).

A critical examination is given of the possibility of extracting reliable Y + N and Y + Y interaction data from a variety of interactions where final state interactions are presumed to be important. The review covers processes suitable for final-state interaction studies, search for stable Y – N bound states, search for B = 2 resonances coupled to the ΛN and ΣN systems (away from YN thresholds), and a search for unstable bound states in the ΣN and ΞN systems (near YN and ΞN thresholds). Also the possibility of extracting scattering lengths for the ΣN and ΛN systems and a study of two-body reactions such as $K^-d \to YN$ and $K^-d \to Y^*N$ are discussed. (J.F.P.)

47461 (CONF-690557-(Vol.1), pp 244-75) THREE-BODY ΛNN FORCES. Nogami, Y. (McMaster Univ., Hamilton (Ontario). Dept. of Physics).

The following topics are discussed: interpretation of three-body ΛNN forces in relation to the one- and two-channel formalisms for the YN interaction, derivation of ΛNN forces from meson theory, effects of ΛNN on Λ-^{3}He, and effects of ΛNN forces on hypernuclear matter, and the validity of the extrapolation procedure to obtain the well-depth of Λ in nuclear matter. (auth)

47462 (CONF-690557-(Vol.1), pp 276-332) PHENOMENOLOGICAL STUDY OF THE S-SHELL HYPERNUCLEI. Tang, Y. C. (Minnesota Univ., Minneapolis. School of Physics).

In order to find values of the effective-range parameters,

binding-energy data of light hypernuclei is used in a phenomenological analysis of the s-shell hypernuclei Λ-^{3}H, Λ-^{4}H, and Λ-^{4}He. Some properties of the Λ-N interactions are found from this analysis. (J.F.P.)

47463 (CONF-690557-(Vol.1), pp 333-47) EFFECT OF ΛN TENSOR FORCE ON $_\Lambda$He^5. Law, J.; Gunye, M. R.; Bhaduri, R. K. (McMaster Univ., Hamilton (Ontario). Dept. of Physics).

The effect of a tensor component in the ΛN force on the binding B_Λ of a Λ particle in Λ-He^5 is investigated using the Hartree-Fock and rigid-α models. Second-order effects of the ΛN tensor force are taken into account in an approximate way. With a variety of ΛN noncentral forces that fit the low-energy Λp scattering data, overbinding of Λ-He^5 persists. For B_Λ calculations in this hypernucleus, the rigid-α model is found to be as good as the more elaborate Hartree-Fock scheme. (auth)

47464 (CONF-690557-(Vol.1), pp 348-67) Λ-BINDING ENERGIES IN THE P-SHELL. Gal, A. (Massachusetts Inst. of Tech., Cambridge).

A review is given of Λ binding energies in the p shell. This discussion covers extensive shell-model and Hartree-Fock calculations. (J.F.P.)

47465 (CONF-690557-(Vol.1), pp 493-520) AN IMPULSIVE LOOK AT STOPPED KAON ABSORPTION. Uretsky, Jack L. (Argonne National Lab., Ill. Northern Illinois Univ., De Kalb).

An analysis of the data on kaon absorption at rest in helium-4 is made using the impulse approximation. Extrapolated Kim amplitudes are used to describe kaon absorption by a single nucleon, and the assumption is made that the residual nucleus holds together unless it undergoes a final-state interaction with a hyperon or pion from the single nucleon absorption process. (J.F.P.)

47466 (CONF-690557-(Vol.2)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON HYPERNUCLEAR PHYSICS HELD AT ARGONNE NATIONAL LABORATORY, MAY 5-7, 1969. VOLUME II. Bodmer, A. R.; Hyman, L. G. (eds.) (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 433p. Dep. CFSTI.

The conference included 25 papers. An individual abstract was prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 47010-47012, 47363, 47372-47375, 47381-47385, 47447, and 47467-47477.

47467 (CONF-690557-(Vol.2), pp 521-97) Λ-PARTICLE BINDING IN NUCLEAR MATTER. Bodmer, A. R. (Illinois Univ., Chicago. Dept. of Physics. Argonne National Lab., Ill.); Rote, D. M. (Illinois Univ., Chicago. Dept. of Physics).

The discussion of lambda particle binding in nuclear matter covers perturbation theory for Λ binding energy as an expansion in powers of the ΛN potential strength, the Brueckner-Bethe g-matrix method, and tensor forces and coupling to the ΣN channel. (J.F.P.)

47468 (CONF-690557-(Vol.2), pp 598-618) STATUS OF JASTROW CALCULATIONS OF THE LAMBDA BINDING ENERGY IN NUCLEAR MATTER. Muelier, G.; Clark, J. W. (Washington Univ., St. Louis, Mo.).

The results of Jastrow calculations of the Λ binding energy in nuclear matter based on the effective central two-body Λ-N potentials of Herndon and Tang are discussed. The possibility of erasing the large discrepancy between these results and the accepted empirical value by the incorporation of a three-body Λ-N-N potential, or by the use of a two-body Λ-N potential with tensor component, is considered, and some tentative numerical work along these lines described. (auth)

47469 (CONF-690557-(Vol.2), pp 619-38) REVIEW OF THE ROLES OF $\Lambda\Lambda$-HYPERNUCLEI. Shamsher, Ali (International Centre for Theoretical Physics, Trieste (Italy). Atomic Energy Centre, Dacca (Pakistan)); Kok, L. P. (Groningen Rijksuniversiteit (Netherlands)); Grypeos, M. E. (Surrey Univ., London (England). Dept. of Physics).

The possible roles of $\Lambda\Lambda$-hypernuclear systems are reviewed. While the studies of the existing $\Lambda\Lambda$ hypernuclei are shown to probe at least in some detail the Λ-Λ interaction, more recent analysis of some of the yet unobserved $\Lambda\Lambda$ hypernuclei points to the possibility that $\Lambda\Lambda$ hypernuclei may also be employed in the role of a probe into the Λ-N interaction as well as into the nuclear core. The importance of experimental information on more $\Lambda\Lambda$ hypernuclei in understanding the interplay between the Λ-N interaction, the Λ-Λ interaction and the nuclear core dynamics is also emphasized. (auth)

47470 (CONF-690557-(Vol. 2), pp 776-80) BINDING ENERGY OF A Λ PARTICLE IN NUCLEAR MATTER. Dabrowski, J.; Hassan, M. Y. M. (International Centre for Theoretical Physics, Trieste (Italy)).

Brueckner type of calculations for the well depth of a Λ particle in nuclear matter is considered. The starting point is the expression for the spin-independent central Λ-N interaction. (J.F.P.)

47471 (CONF-690557-(Vol. 2), pp 796-813) POTENTIAL WELL DEPTH FOR A Λ IN HEAVY HYPERNUCLEI. Downs, B. W.; Kunz, P. D. (Colorado Univ., Boulder).

The central well depth D seen by a Λ bound in a heavy hypernucleus with a local potential of Fermi shape is given for a range of binding energies and potential radii and surface thicknesses covering and extending beyond the current experimental data. Two simple methods for accurately estimating D are also described. (auth)

47472 (CONF-690557-(Vol. 2), pp 814-25) LOW-ENERGY Λ-NUCLEON SCATTERING. Fast, G.; de Swart, J. J. (Nijmegen Univ. (Netherlands)).

The low-energy Λ-nucleon scattering data are reanalyzed with the help of a potential model. The customary 4-parameter effective-range fit can so be replaced by a two-parameter fit. (auth)

47473 (CONF-690557-(Vol. 2), pp 826-41) BINDING ENERGY OF A Λ-PARTICLE IN NUCLEAR MATTER AND Λ-NUCLEON INTERACTION. Grypeos, M. E. (Surrey Univ., London (England). Dept. of Physics); Kok, L. P.; Ali, S. (International Centre for Theoretical Physics, Trieste (Italy)).

Calculations of the binding energy $D_\Lambda = -E_\Lambda$ of a Λ particle in nuclear matter are performed by using the trial expression for the ground-state energy of the Λ particle: E_Λ^{tr} of previous work. The Λ-nucleon correlation function is determined by means of a functional variation (under a suitable integral constraint) of the first order, in density of nuclear matter, contribution to E_Λ^{tr}. The second-order terms are included in the minimization of E_Λ^{tr}, with respect to a parameter related to the Lagrange multiplier, due to the integral constraint. In most of the calculations a reasonable nucleon-nucleon correlation function is used. The Λ-nucleon potentials, which are assumed to be two-body, velocity independent, central, direct potentials with hard cores are taken mostly from the analyses of s-shell supernuclei. The calculated values of D_Λ are in all cases investigated larger than 40 MeV. Comparison with the "experimental value" ($\approx$30 MeV) suggests a suppression of the Λ-nucleon interaction. This could come, for example, from a space exchange component in the two-body Λ-nucleon potential and/or from ΛNN potentials of negative contribution to D_Λ. (auth)

47474 (CONF-690557-(Vol. 2), pp 842-51) LOW-ENERGY Σ-NUCLEON SCATTERING. Helder, J. C.; de Swart, J. J. (Nijmegen Univ. (Netherlands)).

The low-energy Σ^+p scattering data are analyzed with the help of a potential model. A reasonably good fit to the data can only be obtained for such values of the core in the $^3S_1$ state that a Λp resonance in the $^3S_1$ state below the $\Sigma^0 n$ has to be present. Placing this resonance 3 MeV below the $\Sigma^0 n$ threshold determined the $\Sigma^+ p$ effective-range parameters. (auth)

47475 (CONF-690557-(Vol.2), pp 885-8) COUPLED CHANNEL CALCULATION OF UNITARY ANALOG STATES. Kisslinger, L. S. (Case-Western Reserve Univ., Cleveland, Ohio).

Some results of a coupled-channel calculation of unitary analog states of hypernuclei are presented. An optical potential is derived for the meson-nucleus process based on two-body data. The total cross section, integrated over angle and over the energy of the resonance, for the $K^- + {}^{16}O \rightarrow \pi^- + {}_\Lambda O^{16}$ process is given. (J.F.P.)

47476 (CONF-690557-(Vol.2), pp 896-911) ISOMERIC STATE OF $_\Lambda$He^7. Lodhi, M. A. K. (Texas Technological Coll., Lubbock).

It is shown that the isomeric state of Λ-He^7 undergoes Λ decay rather than going to the ground state by E2 transition. Calculations for this transition were performed including a residual potential in the Hamiltonian and nucleon-nucleon correlations in the usual shell-model wave functions of this nucleus. The results of these calculations show that the E2 lifetime is of the order of 10^{-6} sec. (auth)

47477 (CONF-690557-(Vol.2), pp 912-24) PHENOMENOLOGICAL Λ-N POTENTIALS AND Λ BINDING IN NUCLEAR MATTER. Ram, B. (New Mexico State Univ., Las Cruces. Dept. of Physics).

Effective central spin-dependent s-wave Λ-N potentials of a variety of shapes that fit previous scattering lengths are constructed. These potentials are assumed to be appropriate in all

angular momentum states and are used to calculate the binding energy of the Λ particle in nuclear matter, calculate the Λ−N total scattering cross sections and to obtain an approximate measure of the noncentral components in the Λ−N interaction. (J.F.P.)

47478 (UCRL–19851) HIGH-ENERGY HADRON–DEUTERON SCATTERING. Joachain, C. J.; Quigg, C. (California Univ., Berkeley. Lawrence Radiation Lab.). 15 Jun 1970. Contract W-7405-eng-48. 68p. Dep. CFSTI.

Theoretical descriptions of hadron–deuteron scattering at high energies is reviewed. All the specific models have in common the Glauber approximation as their principal ingredient. Considerable effort is devoted to a discussion of forward elastic scattering, for which the theories have reached the highest degree of refinement. The modifications to the simple theory which have emerged from fine structure in experimental cross sections are detailed. The relation between the Glauber picture and Regge theory is analyzed, and the present incompleteness of both approaches is exposed. Brief remarks are made on the anomalous thresholds in energy variables which occur for loosely bound systems, such as the deuteron. Finally more basic generalizations of the Glauber method to include inelastic scattering of the projectile or of one of the constituent nucleons within the deuteron are discussed. A few specific experimental tests are listed. By formulating diffractive excitation of the projectile in terms of the multiple scattering series it is shown how unstable hadron–nucleon elastic scattering may be explored. (auth)

47479 IS THERE ANY SCALING IN ELASTIC PROTON–PROTON SCATTERING? Capra, F. (Stanford Univ., Calif.). Lett. Nuovo Cim.; 4: 215-18(1 Aug 1970).

A critical analysis of two previous fits to experimental data on elastic proton–proton scattering is presented. The data used are cross sections at incoming momenta between 7.1 and 12.1 GeV and angles from 40 to 90°. The purpose of the analysis is to determine whether the elastic p + p cross sections become a function of a single variable in the limit of high energies and large angles. This behavior is called scaling. It is found that these fits do not reflect any scaling property of the elastic p + p cross section in the considered energy range and can only be taken as crude approximations to the data. (J.F.P.)

47480 ONE-BOSON-EXCHANGE MODEL OF NUCLEON–NUCLEON BREMSSTRAHLUNG. Baier, R.; Kuehnelt, H.; Urban, P. (Univ., Graz). Acta Phys. Austr.; 29: 371-5(1969). (In German).

A fully relativistic and gauge invariant calculation is made for the cross section for $N + N \rightarrow N + N + \gamma$ interactions at 100 to 200 MeV, using a one-boson-exchange model which also describes the elastic scattering. (L.B.S.)

47481 COHERENT PRODUCTION OF PARTICLES ON NUCLEI BY HIGH ENERGY HADRONS. Rybicki, Krzysztof (Inst. of Nuclear Research, Krakow). Postepy Fiz.; 21: 347-67(1970). (In Polish).

The coherent production of particles in hadron-nucleus collisions at high energy is described. A theoretical description of this process (also including absorption in the nucleus) is sketched. The main experimental results on the coherent interaction of pions, kaons and protons with the nuclei are described at an energy ranging from a few GeV up to several hundreds GeV. The advantages of the study of resonances produced in this process are presented. An energy dependence of the coherent cross section is discussed. (auth)

47482 RELATIVISTIC FORM FACTOR OF THE TRITON AND THE ALPHA PARTICLE. Cocho, G.; Flores, J. (Univ. Nacional de Mexico, Mexico City). Rev. Mex. Fis.; 19: No. 1, 67-88(1970).

Using the methods of group theory, an explicit expression for the form factor of a few-particle system is obtained which is valid at very high momentum transfers. The formalism is applied to obtain the form factors of the three- and four-nucleon systems. An analysis of the error made in the nonrelativistic approximation is performed. (auth)

Particle Invariance Principles and Symmetries

General

47483 FIRST-ORDER DEFORMATIONS OF REPRESENTATIONS OF SEMISIMPLE LIE ALGEBRAS. I. AN EXAMPLE: THE ALGEBRA OF THE SL(2,C) GROUP. Berendt, G. (Deutsches Elektronen-Synchrotron, Hamburg). Acta Phys. Austr.; 29: 365-70(1969).

The possibility of first order deformations of the irreducible unitary representations of the Lie algebra of SL(2,C) relative to the SU(2) subalgebra is discussed. It is shown that — in agreement with the intuitive picture — the so-called continuous series of representations can be deformed, while the discrete series is rigid. (auth)

47484 SU(1,1) ANALYSIS OF DUAL RESONANCE MODELS. Clavelli, L.; Ramond, P. (National Accelerator Lab., Batavia, Ill.). Phys. Rev., D; 2: 973-9(15 Sep 1970).

The representations of the noncompact group SU(1,1) are discussed with regard to applications to dual resonance models. The Gliozzi operators are constructed from a standard differential representation of SU(1,1). It is pointed out that the delicate limiting procedure appearing in the recent literature has its group-theoretical basis in the fact that SU(1,1), unlike its compact counterpart SU(2), has no nontrivial unitary spin-0 representation. It is further noted that the vertex appearing in the model effectively transforms as the spin-α_0 representation of the continuous class, exceptional interval, of SU(1,1). The N-point dual amplitude then appears as the coupling of N such vertices to the identity. Finally, the classification of the states in the model under the group is discussed. A complete classification in terms of SU(1,1) is shown to break down at $\alpha(s) = 8$ on and below the fourth daughter trajectory. (auth)

47485 REFORMULATION OF THE DIRAC–FIERZ–PAULI EQUATION FOR SPIN 3/2. Tani, S. (Marquette Univ., Milwaukee). Phys. Rev., D; 2: 980-8(15 Sep 1970).

The $(1,\frac{1}{2}) \oplus (\frac{1}{2},1)$ irreducible representation of the homogeneous Lorentz group is studied thoroughly. Though the starting point is the original version of the spinor equation due to Dirac and Fierz, an algebraic method is used and all necessary transformation functions and projection operators are derived. Consequently, a physical significance of each mathematical operation immediately is seen. There are two kinds of particles in this representation: One has mass m and spin $\frac{3}{2}$ in the rest system, the other mass 2m and spin $\frac{1}{2}$. A projection operator to a subspace for each type of particle is Lorentz invariant. There are four γ matrices which transform like components of a four-vector. The inverse of the operator which defines the equation of motion for a free particle will define the (Lorentz-invariant) propagator. Unfortunately, it is hard to carry out the canonical quantization, and the same propagator cannot be derived by a canonical method. The algebraic method suggested here will be very useful when the theory is extended by adding a $(\frac{1}{2},0) \oplus (0,\frac{1}{2})$ representation, as is done by Pauli and Fierz, Gupta, and others. (auth)

47486 UNITARY SYMMETRY AND ELEMENTARY PARTICLES. Lichtenberg, D. B. New York; Academic Press Inc. (1970). 256p. $13.00.

An introduction to the concepts in group theory that are most useful in understanding unitary symmetry is presented. Emphasis is given to SU(3) symmetry. The conservation laws of physics, and the relevance of group theory to the symmetry properties of elementary-particle interactions are discussed. A summary is given on the fundamental ideas of group theory and group representations, with emphasis on simple Lie groups and their algebras. Methods using Young tableaux and raising and lowering operators are stressed. In the applications to elementary particle physics, special emphasis is given to the strong interactions of mesons and baryons. Also included is a discussion of elementary particles within the framework of models which incorporate broken SU(3) symmetry, including the quark model and its variations. (L.B.S.)

47487 FORMAL THEORY OF NONLINEAR REALIZATION OF A GROUP ON ITS SUBGROUP. Okabayashi, Takao; Watanabe, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto); 43: 1343-63(May 1970).

An attempt is made to construct a comprehensive scheme of the theory of nonlinear realization of a Lie group G on its subgroup H. The groups G with a subgroup H are classified through the reality of preferred fields and the numbers of self-conjugated preferred fields and of conjugate pairs of preferred fields. As prototypes of general cases two special classes, a single self-conjugate preferred field case and the case of a conjugate pair of preferred fields, are discussed in detail. (L.B.S.)

Applications (Electromagnetic and Weak)

47488 (SINP-TH-67-2) LEPTONIC DECAYS OF BARYONS AND T-VIOLATION. Dutta-Roy, B.; Baba Pundari, S. (Saha

Inst. of Nuclear Physics, Calcutta (India)). [nd]. 8p. Dep. CFSTI (U. S. Sales Only).

A phenomenological model of T-violation for the leptonic decays of baryons is presented which yields markedly different results from those given by the model proposed by Jackson, Treiman, and Wyld; for instance, the decay asymmetry (of the plane containing the electron and neutrino momenta with respect to the direction of polarization of the decaying baryon) has, in the present model, an interesting dependence on the electron energy. The possibility of such an energy dependence of the above mentioned T-violating asymmetry should be borne in mind, in planning experiments to test T-invariance in the leptonic decays of baryons, and in discriminating between the two models. (auth)

47489 SIMULATED T-VIOLATION EFFECTS IN ELASTIC ELECTRON–PROTON SCATTERING. Leibbrandt, G. (Univ. of Guelph, Ont.). Nuovo Cim.; 69A: 153-74(21 Sep 1970).

An algebraic derivation is given of simulated T violations in an elastic electromagnetic process. The theoretical differential cross section $d\sigma$ for high-energy elastic electron-proton scattering is shown to contain certain spin-momentum correlations $A_{e,m,s} \cdot p_1 \times p_2$ which seem to violate time reversal T. Since the primary electromagnetic-interaction Hamiltonian is assumed to be C and T invariant, the appearance of such triple scalar products in $d\sigma$ implies a simulated violation in T. The present computation shows that these simulated violations can occur even in elastic processe where they specifically arise from the interference between the real second-order amplitude and the imaginary fourth-order amplitude. The calculation includes both crossed and uncrossed Feynman graphs to fourth order in e. There is no cancellation of the relevant terms to order e^4. The cross section for simulated effects, for the subamplitude M_3, is found to be $d\sigma/d\Omega_3 \approx 0.25$ (10^{-30}) cm^2/sr at a laboratory angle $\theta = 20°$, $-q^2 = 2.28(GeV/c)^2$ and an incident electron energy $E_2 = 5GeV/c$. Symmetry arguments concerning triple scalar products are based on the validity of the CPT theorem. (auth)

Applications (Strong)

Refer also to abstract 47428.

47490 (SINP-TH-67-1) POSITIVE PARITY MESONIC STATES AND UNITARY SYMMETRY. Dutta-Roy, B.; Baba Pundari, S. (Saha Inst. of Nuclear Physics, Calcutta (India)). [nd]. 7p. Dep. CFSTI (U. S. Sales Only).

Evidence is presented for an octet of 0^+ (scalar) mesons and a nonet of 1^+ (axial-vector) mesons, which may together form a 35-plet SU(6)-supermultiplet. Predictions are made for masses and decay widths of the 35^+-plet resonances. It is noted that the s-wave decay $35^+ \to 35^- + 35^-$ is not forbidden by SU(6), which is the first physically realized case where decays are not forbidden by pure SU(6). (L.B.S.)

47491 DISPERSION SUM RULES FOR THE CHIRAL-SYMMETRY-BREAKING PARAMETER. Radescu, E. E. (Inst. of Atomic Physics, Bucharest). Lett. Nuovo Cim.; 4: 206-10(1 Aug 1970)

Using some mass extrapolation techniques a somewhat more elaborate determination of the symmetry-breaking parameter c which appears in the strong-interaction Hamiltonian is given. This parameter c is estimated in terms of the kaon and pion masses. The conditions required for the approximate validity of this estimate are given. (J.F.P.)

47492 SYMMETRY BREAKING IN THE HARD-MESON CURRENT-ALGEBRAIC TREE-GRAPH THEORY. Pande, L. K. (Ohio State Univ., Columbus. Univ. of Texas, Austin). Lett. Nuovo Cim.; 4: 193-8(1 Aug 1970).

A formula is derived for the parameter which characterizes the symmetry breaking in the hard-meson current-algebraic tree-graph theory of mesons. (J.F.P.)

47493 DIOPHANTINE QUANTIZATION: APPLICATION OF THE METHODS OF ALGEBRAIC NUMBER THEORY TO THE THEORY OF ELEMENTARY PARTICLES. Pease, Robert L. (State University Coll., New Paltz, N. Y.). Phys. Rev., D; 2: 1069-71(15 Sep 1970).

The Gell-Mann–Okubo broken-SU(3) meson mass formula is treated as a quadratic Diophantine equation and solved in integers. The relative masses of π, η, K, many known K^*, and the probable lowest L may be predicted unambiguously. The requirement of least-integer solutions mandates a unit mass of 70 MeV (137 $m_e c^2$). Connections between rest masses and angular momenta can be made, and there is evidence of a general linear group. (auth)

47494 NONLINEAR REALIZATIONS OF GROUPS AND CHIRAL TRANSFORMATIONS IN THE QUARK MODEL. Hattori, Chuichiro; Kobayashi, Makoto; Kondo, Hiroki; Maskawa, Toshihide (Nagoya Univ., Japan. Saga Univ., Japan). Progr. Theor. Phys. (Kyoto); 43: 1334-42(May 1970).

The nonlinear realizations of a compact, connected Lie group are studied. The problem of the linearization is discussed in detail on the basis of the topological structure of the group. It is shown that, in the quark model, the nonlinear realizations of the chiral $SU(3) \otimes SU(3)$ can be linearized through redefinition of field variables, but this is not generally the case for $U(3) \otimes U(3)$. (auth)

47495 CONFORMAL INVARIANCE IN THE DUAL SYMMETRIC THEORY OF HADRONS. Galli, A. (Yeshiva Univ., New York). Nuovo Cim.; 69A: 275-89(21 Sep 1970).

In the space-time picture for dual-resonance models proposed by Susskind the group SL_{1R} suggested as the group of gauge transformations for this theory is considered. The analysis of disc-preserving mappings in a Lagrangian scheme provides the expression for the operator that generates the linear relations for the first mode and, by an extension, those found by Virasoro for all modes. (auth)

Field Theories

Quantum Field Theory

Refer also to abstract 47400.

47496 (LNF-70/23) QED TESTS IN THE TIME-LIKE REGION. Note No. 479. Felicetti, F. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). 15 May 1970. 30p. Dep. CFSTI (U. S. Sales Only).

Quantum electrodynamics tests in the time-like lepton region are considered. It is examined in what direction and to what extent a breakdown of the theory can occur consistent with established experimental and theoretical results. Also some experimental tests of quantum electrodynamics are discussed. (J.F.P.)

47497 NONEXISTENCE OF SCHWINGER TERMS IN SPINOR QUANTUM ELECTRODYNAMICS. Boulware, David G.; Herbert, Jack (Univ. of Washington, Seattle). Contract RLO-1388B. Phys. Rev., D; 2: 1055-60(15 Sep 1970).

The equal-time commutator between the space and time components of the electromagnetic current in spinor electrodynamics is calculated, to order α, using the technique of Johnson, Low, and Bjorken; it is found to be a c number. An argument is presented which indicates that the commutator is a c number in all orders of perturbation theory. (auth)

47498 FINITE THEORY OF QUANTUM ELECTRODYNAMICS. Lee, T. D.; Wick, G. C. (Columbia Univ., New York). Phys. Rev., D; 2: 1033-48(15 Sep 1970).

A new theory of quantum electrodynamics is presented, which is relativistically invariant, gauge invariant, unitary, and free of divergences. In this theory, mass renormalization, charge renormalization, and wave-function renormalization are all finite. Experimental consequences are discussed, and theoretical implications, especially those related to causality, are analyzed. (auth)

47499 EFFECTIVE LAGRANGIANS ASSOCIATED WITH MASSIVE GAUGE FIELD. Finkelstein, R.; Staunton, L. (Univ. of California, Los Angeles). Physica; 47: 182-212(29 May 1970).

An earlier discussion of a massive gauge field interacting with a massless fermion field is extended to include the possibility that the fermion field is also massive. The pseudoscalar particles, which are associated with the massive vector and may be transformed away when the fermion is massless, can no longer be transformed away when the latter is massive. The present procedure very strongly determines a chiral invariant Lagrangian similar to forms considered by other authors. The usual low energy results are obtained, but in addition the nonlinearities are treated exactly and succinctly with the aid of the group geometrical techniques introduced in our earlier work. (auth)

47500 CURRENT COMMUTATION RELATIONS IN THE FREE TWO- AND FOUR-DIMENSIONAL DIRAC FIELD. Rupertsberger, H. (Univ., Vienna). Acta Phys. Austr.; 29: 300-12(1969).

In the two- and four-dimensional free Dirac field the currents

are defined by an appropriate limiting process and within this limit definition the commutation relations of the current densities are calculated. A problem connected with the fulfilment of the Jacobi-identity is also discussed. (auth)

47501 FEYNMAN RULES FOR AN O(4) FAMILY WITH NO GHOSTS. Chang, Ngee-pong; Nelson, Charles A. (City Coll., New York). Phys. Rev., D; 2: 959-65(15 Sep 1970).

When a resonance is observed in an experiment, it is usually assumed that the resonance has a definite spin J. Should, however, an O(4) family of Regge trajectories hit the physical region, a family of resonances of different spins roughly degenerate in energy is expected. For such a family of resonances, there should presumably be a master field which contains all the spins in the family and which interacts as a unit with other hadrons. The general tensor construction of such multispin fields is discussed. It is believed that the splitting of the A_2 meson is a manifestation of a master field and, in a following paper, the phenomenology of the O(4) resonance system is studied. (auth)

47502 SPINOR FIELD GROUND STATE AND GLOBAL EXCITATIONS. Maier-Boetzel, H.; Bopp, F. (Univ., Munich). Phys. Lett.; 32B: 616-18(31 Aug 1970).

Rather exact energies for the ground state (vacuum) and for global excitation states of a Heisenberg type spinor field theory in a lattice space are obtained by the inverse perturbation method. (auth)

47503 BOREL SUMMABILITY: APPLICATION TO THE ANHARMONIC OSCILLATOR. Graffi, S. (Istituto Nazionale di Fisica Nucleare, Bologna); Grecchi, V.; Simon, B. Phys. Lett.; 32B: 631-4(31 Aug 1970).

It is proved that the energy levels of an arbitrary anharmonic oscillator (x^{2m} and in any finite number of dimensions) are determined uniquely by their Rayleigh–Schrödinger series via a (generalized) Borel summability method. To use this method for computations, an analytic continuation must be made which is accomplished by (a rigorously unjustified) use of Padé approximants in the case of $p^2 + x^2 + \beta x^4$. The numerical results appear to be better than with the direct use of Padé approximants. (auth)

47504 QUANTUM GRAVITY AND INFINITIES IN QUANTUM ELECTRODYNAMICS. Salam, A.; Strathdee, J. (International Centre for Theoretical Physics, Trieste, Italy). Lett. Nuovo Cim.; 4: 101-8(18 Jul 1970).

It was previously found that the vierbein–gravity Lagrangians of particle physics would be free of all infinities if calculations were made nonperturbatively in the constant κ. The results of such nonperturbative calculations which are of second order in e for self-mass and self-charge are presented. As a result it is found that the gravitational effects appear in the form $\kappa^n \log \kappa$ and $\kappa^n (\log \kappa)^2$. The gravitational length κ thus provides the natural inbuilt cut-off for electrodynamics, the infinities of the unmodified Dirac Lagrangian being a reflection of the limit of gravity having been neglected ($\kappa = 0$) and an attempt to expand $\log \kappa$ round $\kappa = 0$. (J.F.P.)

47505 HAMILTONIAN FORM OF MAXWELL'S EQUATIONS. Sankaranarayanan, A. (Douglas Advanced Research Labs., Huntington Beach, Calif. California State Coll., Long Beach). Progr. Theor. Phys. (Kyoto); 43: 1204-12(May 1970).

Maxwell equations in vacuum are recast in a Hamiltonian form which is analogous to the Sakata–Taketani equation describing particles with spin one and non-zero rest mass. Various properties of the new equation are then briefly discussed. (auth)

47506 HYPERQUANTIZATION OF THE ELECTROMAGNETIC AND SPIN-1/2 FIELDS. Dormuth, K.; Takahashi, Y. (Univ. of Alberta, Edmonton). Progr. Theor. Phys. (Kyoto); 43: 1386-1400(May 1970).

The formalism of hyperquantization is applied to the quantum electrodynamics of a spin-$\frac{1}{2}$ field. The result is a gauge invariant theory containing an operator S whose matrix elements agree with those of the conventional S-matrix, but in which the use of the indefinite metric can be avoided. Dyson's equations and the generalized Ward identity are derived within this formalism. (auth)

Gravitation and General Relativity

47507 STUDY OF THE GRAVITON EMISSION PROCESS. Tourrenc, Andre (Paris Univ.). Compt. Rend., Ser. B; 271: 69-72(15 Jul 1970). (In French).

The process of the annihilation of a pair of photons into a pair of gravitons, and the emission of an infrared graviton in the collision process of two scalar particles (Bremsstrahlung), are studied. (auth) (France)

47508 UNIQUENESS OF THE QUADRATIC ACTION LAGRANGIAN IN GENERAL RELATIVITY. Gogala, B. (Univ. of British Columbia, Vancouver). Can. J. Phys.; 48: 1924-32(15 Aug 1970).

A procedure, suitable for translation into computer language and analogous to the uniqueness proof of Einstein's field equations in vierbein formulation, is developed for finding the most general quadratic action Lagrangian density in general relativity that satisfies the requirement of covariance and of invariance under coordinate dependent frame reorientation. It is found that this Lagrangian is identical with the most general linear combination that can be made up out of the three scalars formed by bilinear combinations of the Riemann curvature tensor. (auth) (Canada)

47509 TRAJECTORIES OF PARTICLES WITH SPIN IN A LINEARIZED GRAVITATIONAL FIELD. Lawrence, John K. (Univ., Vienna). Acta Phys. Austr.; 30: 313-22(1969).

A calculation is made of the trajectories of massive spin-1 and spin-$\frac{1}{2}$ particles in a linearized gravitational field starting with the covariant vector and Dirac field equations. The particle limit is taken in the sense of a "quasi-WKB approximation" in which all $\hbar$'s in the theory are set to zero except those of the spin angular momentum. The spin-1 particles are found to follow geodesics, while an additional spin-gravitation interaction term enters into the Fermion equations of motion. The spin tensor arising from the Dirac equation obeys constraints which ensure conservation of angular momentum. Effects on the result of a Dicke–Eötvös type experiment would be at least second order in the gravitational fields. The correction to the geodesic deflection of high energy fermions passing near a massive body is calculated. (auth)

47510 LORENTZ-INVARIANT GRAVITATIONAL THEORY. Mittelstaedt, Peter. Arbeitsgemeinsch. Forsch. Landes Nordrhein-Westfalen; No. 202, 27p(1970). (In German).

The theory of gravitation, which has been formulated in the framework of Einstein's general theory of relativity, has an exceptional position in respect to modern field theories, since it is formulated in a Riemannian space, which is determined by the motion of mass points and light rays. The attempt to construct a theory of gravitation on the same principles on which usually field theories are based leads to a symmetric tensor field. Using the equations of motion for mass points and light rays, which serve also as measuring devices for space-time intervals, the theory can be reformulated into a theory which contains exclusively observable quantities. This theory is identical with Einstein's theory of gravitation. The possibility to interpret Einstein's theory of gravitation either as a theory in a Riemannian space or as a Lorentz-invariant field theory in the Euclidian space, exists as well for local problems as for a few global problems, which are connected with the structure of the universe. (auth)

Scattering Theory

47511 (JINR-P2-5150) EIKONAL REPRESENTATION FOR THE AMPLITUDE OF SPINOR PARTICLE SCATTERING ON AN ARBITRARY POTENTIAL. Pervushin, V. N. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1970. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An eikonal representation is obtained for the amplitude of Dirac particle scattering on an arbitrary potential. The cases of scalar, pseudoscalar, vector, axial, and tensor potentials are discussed. As it turned out at an infinitely high energy of a scattering particle the nonvanishing contribution to the spin-amplitude can be given only by tensor potential. (auth)

47512 (SINP-TH-67-6) MODIFIED REGGE REPRESENTATION. Mukherjee, Suprokash (Saha Inst. of Nuclear Physics, Calcutta (India)). [nd]. 12p. Dep. CFSTI (U. S. Sales Only).

A new Regge-type-representation for the scattering amplitude is proposed, which has correct asymptotic behavior for small k and large λ and small background integral. (auth)

47513 SECOND-SHEET POLES AND THE MAXIMUM BEHAVIOR OF REGGE TRAJECTORIES AT INFINITY. Childers, R. W. (Univ. of Tennessee, Knoxville). Phys. Rev., D; 2: 1178-80(15 Sep 1970).

It is found that Regge trajectories cannot increase faster than linearly as $s \to \infty$ in any direction on the physical sheet of the complex s plane. Further, if $\mathrm{Re}\alpha(s)$ increases more rapidly than $\mathrm{Im}\alpha(s)$ as $s \to +\infty$, the trajectories must be asymptotically linear. These results are valid only to within possible logarithmic factors and are a consequence of the generally assumed

absence of resonance poles on the physical sheet. Other assumptions are as follows. (i) $\alpha(s)$ is real analytic in the s plane cut from threshold (s_0) to $+\infty$. (ii) $\mathrm{Im}\alpha(s) \geq 0$ for $s_0 \leq s < +\infty$. (iii) $\alpha(s)$ is continuous on the cut and increases no faster than a power of s as $s \to +\infty$, i.e., along the positive real axis. (iv) As $s \to \infty$ in complex directions, $|\alpha|$ increases no faster than a power of exp ($|s|$). (auth)

47514 ASYMPTOTIC BEHAVIOR OF THE SCHROEDINGER WAVE FUNCTION FOR LARGE TIME PERIODS. APPLICATION TO THE THEORY OF DECAYING SYSTEMS. Kilian, Hans (Philipps-Univ., Marburg, Ger.). Acta Phys. Austr.; 30: 152-63(1969). (In German).

The asymptotic behavior of the Schrödinger wave functions $\Psi(\vec{r},t)$ arising in the theory of potential scattering for $t \to \infty$ and r fixed as well as for a moving observer ($r = vt$, v constant) is investigated. As a result it is found that these wave functions may asymptotically fall off as slowly as $t^{-\frac{1}{2}}$ or more rapidly than any power of t^{-1} depending on the probability amplitude for finding very slow particles. As an application it is concluded that the power terms usually found in the otherwise exponential decay law of decaying systems have nothing to do with these decaying systems but are caused by the model or the approximations necessary for an evaluation of the integrals which describe the decay probability. (auth)

47515 SET OF CROSSING-SYMMETRIC DYNAMICAL EQUATIONS AND INFINITELY RISING REGGE TRAJECTORIES. Balazs, Louis A. (Univ. of California, Los Angeles). Phys. Rev., D; 2: 999-1009(15 Sep 1970).

An equation based on unitarity and analyticity is written down. It is a relativistic generalization of a Schrödinger equation with a local energy-dependent potential of the Yukawa type, in contrast to the usual Mandelstam equations, which correspond to a nonlocal energy-independent potential. A prescription is given for our potential, which makes the amplitude exactly crossing symmetric. It is argued that a first guess at the potential might simply be to take the low-energy crossed-channel resonances of the Veneziano model. The cutoff on the number of resonances is then an undetermined parameter, which, however, merely serves to fix the energy scale in the limit of a vanishingly small pion mass. A determinantal approximation to our scheme (which differs from the determinantal approximation to the usual N/D equations) is then found to lead to Regge trajectories which rise indefinitely. The I = 1 output resonances agree approximately with the input ones, average duality is found to be satisfied, and the P-wave scattering length comes out close to the Weinberg value. These results do not change much, at least at low energies, even if a strong dose of inelasticity is introduced. (auth)

47516 MULTIFACTORIZATIONS AND THE FOUR-REGGEON VERTEX FUNCTION IN THE DUAL RESONANCE MODELS. Yu, Loh-ping (Univ. of California, Berkeley). Phys. Rev., D; 2: 1010-22(15 Sep 1970).

By repeatedly factorizing the Koba–Nielsen representation of the N-point dual amplitude, an amplitude can be obtained with an arbitrary number of excited legs. In particular, an operator form of the four-Reggeon vertex function is found. (auth)

47517 FULLY REGGEIZED SCATTERING AMPLITUDES. Domokos, G.; Kovesi-Domokos, S.; Schonberg, E. (Johns Hopkins Univ., Baltimore). Contract AT(30-1)-4076. Phys. Rev., D; 2: 1026-32(15 Sep 1970).

Some restrictions imposed on scattering amplitudes of hadrons by Lorentz covariance and the requirement that external as well as virtual particles lie on Regge trajectories (fully Reggeized scattering amplitudes) are investigated. A generalized Fourier–Mellin integral representation is proposed which expresses these requirements and plays the role of a generalized partial-wave expansion. In the pole approximation, the proposed representation automatically contains local duality and for spinless external particles it reduces to the Veneziano formula. (auth)

47518 MASSLESS PARTICLES WITH INFINITE SPIN. Murphy, Joseph E. (City Coll., New York). Phys. Rev., D; 2: 1049-55(15 Sep 1970).

Reducible free fields of massless particles with infinite spin, transforming covariantly under the Poincaré group, are constructed. The fields are linear combinations of annihilation and creation operators for massless particles summed over all possible spin values. Some sufficient conditions are given for satisfying the causality requirement, and no necessary connection between spin and statistics is found. Fermi and Bose fields can be quantized so as to satisfy causality with or without the usual spin-statistics relation. Covariant propagators for these fields are exhibited and the scattering amplitude is calculated in lowest order for two interaction Lagrangians. (auth)

47519 ANALYTICITY OF THE TWO-BODY RELATIVISTIC PARTIAL WAVE AMPLITUDES. Blazek, M. (Inst. of Physics, Bratislava). Acta Phys. Austr.; 29: 376-83(1969).

It is shown that in the case of a general two-body in two-body inelastic process, the denominators of the Mandelstam representation, arising from the crossed channel processes, vanish in an area of the complex energy squared plane, s, as far as the momentum transfer squared, t (or u), and the scattering angle in the direct channel, $\cos\theta$, have their physical values. This fact represents a difference from any elastic case where only isolated lines occur. Then, for a general process, the necessity for performing the analytic continuation (at least) in the complex either $\cos\theta$ or t plane follows. In the s-plane, the equations of the lines are given along which both t and $\cos\theta$ are real and (i) t is fixed and $\cos\theta$ varies, (ii) $\cos\theta$ is fixed and t varies. In the case of an elastic process, these equations yield the well-known results. If the continua in the crossed channels are replaced by particles (in a general sense), the suggestion may be accepted that the corresponding branch points of a partial wave amplitude, in the s-plane, are to be connected along the lines mentioned above sub (i). This suggestion with its consequences is briefly discussed. (auth)

47520 MOVING BRANCH POINTS IN THE ANGULAR MOMENTUM PLANE. Ando, Fujio (Dublin Inst. for Advanced Studies). Phys. Rev., D; 2: 1136-9(15 Sep 1970).

A possibility of producing the Regge cut in the direct-channel partial waves is studied, without invoking the production amplitudes. If the Van Hove model modified with a finite width is incorporated into the intermediate state, the moving branch point results, owing to the pinch of the two types of singularities. The model suggests a possible mechanism of vanishing discontinuity at the branch point. (auth)

47521 TEST OF THE PADE-APPROXIMANT APPROACH IN THE COULOMB BOUND-STATE PROBLEM. Crater, Horace W. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., D; 2: 1060-2(15 Sep 1970).

A model of scalar positronium is examined for the purpose of testing Padé approximants in the Coulomb problem and it is found that the (1,1) Padé approximant for the amplitude comprised of the Born term, the box, and the cross-box diagrams predicts an infinite number of bound states. Although the O(4) symmetry is preserved, the spectrum obtained is not the relativistic Balmer formula derived by the eikonal approximation or other conventional methods. A recent method of extracting a relativistic Balmer formula (with all recoil effects) from the eikonal approximation is found to be equivalent to summing up definite portions of the (crossed) ladder diagrams. The (1,1) Padé approximant deduced from the first two terms of this approximate series yields exactly the same result. (auth)

47522 N-PARTICLE DUAL AMPLITUDE WITH SATELLITES: WARD-LIKE IDENTITIES. Rivers, R. J. (Univ. of Chicago). Phys. Rev., D; 2: 1063-8(15 Sep 1970).

A large class of N-point functions with satellites factorized in a multiperipheral configuration is examined. It is shown that the Ward-like identities due to reflection invariance do not lead to a reduction in degeneracy due to a partial ghost elimination, but merely lead to the introduction of new states. This is considered to be a more serious disadvantage to the model than the large mass degeneracy that satellites imply. (auth)

47523 UNITARY NONPLANAR CLOSED LOOPS. II. Thorn, Chalres B. (Univ. of California, Berkeley). Phys. Rev., D; 2: 1071-80(15 Sep 1970).

Using the methods developed in a previous paper, the calculation of the dual amplitude is generalized for a nonplanar diagram with a single closed loop to the case with an arbitrary number of "twisted vertices." Just as with the four-point function discussed in the previous paper, it is found that, if the amplitude is written $M = \int_\Sigma d^4\Pi\, M(\Pi)$, $M(\Pi)$ is periodic in Π, the period being given by the sum of the four-momenta of the "twisted vertices." It is then shown in the general case that the prescription of choosing Σ to range over just one period yields the imaginary part required by perturbative unitarity. It is verified that M so defined is dual in three different ways. It is shown explicitly that the result is equivalent to the Kikkawa–Klein–Sakita–Virasoro (KKSV) prescription; duality is also proved directly from the Bardakci-Ruegg-like form without reference to the KKSV structure; and finally it is shown that duality is manifest within the operator formalism before the trace is performed. (auth)

47524 REGGEIZED RESONANCE MODEL FOR THE POMERANCHUK TERMS. Ohba, Ichiro (Waseda Univ., Tokyo). Progr. Theor. Phys. (Kyoto); 43: 1301-6(May 1970).

Using the n-point Reggeized resonance function, the elastic scalar boson-scalar boson scattering amplitude is calculated

directly through unitarity. Relations between the Pomeranchuk trajectory and the input trajectories are obtained. (auth)

47525 CONSISTENT MULTIPLE FACTORIZATION OF DUAL AMPLITUDES. Collop, D. J.; Drummond, I. T. (Cambridge Univ., Eng.). Nuovo Cim.; 69A: 261-74(21 Sep 1970).

Using operational formalism, a scattering amplitude for an arbitrary number of spinning particles is constructed. The amplitude satisfies duality when the particles are put on their mass shells and exhibits the same factorization spectrum as the amplitudes for scalar particles. (auth)

Particle Accelerators

Refer also to abstracts 46207, 46516, 46549, 46757, 46771, 47298, 47356, and 47555.

47526 (BRH/DEP-70-18) BREMSSTRAHLUNG PRODUCTION. Brown, David G. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Jul 1970. 19p. CFSTI.

An understanding of bremsstrahlung production is basic to the understanding of x radiation from electronic products. For this reason the Division of Electronic Products has conducted a bremsstrahlung literature survey and has begun a program of experimental research on bremsstrahlung production. The literature survey revealed severe deficiencies in present knowledge about bremsstrahlung, indicating that the DEP program is urgently needed. (31 references) (auth)

47527 (BRH/DEP-70-22) REPORT OF TESTS FOR X-RAY EMISSION FROM A RAYOTRON ELECTROSTATIC GENERATOR AND PARTICLE ACCELERATOR. Miller, Edwin A. (Bureau of Radiological Health, Rockville, Md. Div. of Electronic Products). Aug 1970. 20p. CFSTI.

A study undertaken by the Product Testing and Evaluation Branch to evaluate the radiation hazards associated with a small electrostatic generator and particle accelerator used for educational purposes is described. Laboratory measurements of the x-ray emission are presented, and comments are offered regarding the safety instructions provided with the device. Test findings are compared to the proposed performance standard for demonstration-type cold-cathode gas discharge tubes, since the final version of the standard had not been published at the time this work was performed. (auth)

47528 (CERN-70-13) MATHEMATICAL MODEL FOR UNDERSTANDING THE CROSS MODE EXCITATIONS IN DEE-DUMMY DEE STRUCTURES OF SYNCHRO-CYCLOTRONS. Bucci, O. M.; Franceschetti, G. (Istituto Universitario Navale, Naples (Italy). Naples Univ. (Italy)). 30 Apr 1970. 27p. Dep. CFSTI (U. S. Sales Only).

A mathematical model is proposed to facilitate the study of the cross-mode excitation in the Dee-Dummy Dee (D-DD) accelerating structure in synchrocyclotrons. Modes of the electromagnetic field in the D-DD structure, free resonances of the D-DD structure, and excitation of modes into the D-DD structure are considered. (W.H.K.)

47529 (JINR-P9-5090) RELATIVISTIC SOLITONS AND NONLINEAR WAVES AS BUNCHES FOR COHERENT ACCELERATION. Tsytovich, V. N. (Joint Inst. for Nuclear, Dubna (USSR)). 1970. 14p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The structure of nonlinear waves and solitons with phase velocities near to the light velocity has been considered. It is shown that maximum potential difference in such waves can reach the value $2m_ec^2\gamma^2$ and the maximum electric field strength is of the order $E \approx \sqrt{n_0 m_e c^2 \gamma}\,(8\pi/3)$, $\gamma = [1 - (v^2/c^2)^{-1/2}]$. The problems of excitation of these waves with the help of relativistic electron beams and relativistic electron rings have been discussed. The maximum electric field strength in solitons that are propagating across the magnetic field can be of the order of the external magnetic field strength. (auth)

47530 (JINR-P9-5142) ON A TEMPORARY EFFECT OF THE ACCELERATING FIELD ON THE ELECTRON BUNCH CONTAINING IONS. Bonch-Osmolovskii, A. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). 1970. 12p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A problem of a temporary effect of the field on the electron bunch containing ions is considered. The conditions are derived under which the ions are confined within the geometrical dimensions of the bunch at a single and recurrent action of the field accelerating the bunch. (auth)

47531 (KHFTI-69-20) CONCERNING WAYS TO STABILIZE THE BASIC PARAMETERS OF THE BEAM OF A LINEAR ACCELERATOR OF ELECTRONS WITH ENERGY 2 GeV. Grishaev, I. A.; Kolosov, V. I.; Krasnikov, V. D.; Mel'nichenko, V. V. (Akademiya Nauk Ukrainskoi SSR, Kharkov. Fiziko-Tekhnicheskii Institut). 1969. 6p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The fundamental parameters, such as beam intensity, energy spectrum, divergence, etc. of the extracted beam of the electron accelerator were studied in order to determine the nature of the instabilities under steady-state operation at 1200 MeV with a mean beam current of 0.3 to 0.4 μA. The effects of injector-accelerator system on the parameters of the accelerated electron beam were examined on the basis of static characteristics. The results indicated that the mean current of the klystron accelerator and the excitation phase are the most critical parameters. The analysis made it possible to select the optimum number of local stabilizers; one of them stabilizes the electron heating of the beam, the second maintains the phase of the electron clusters, the third stabilizes the energy of the accelerated electrons against the general drift of the system, while the fourth keeps the beam on the target. The large number of experimental devices prevent the dispatcher from considering the large volume of information; therefore, the system was automated, installing a central control board containing a digital controller and diagnostic instrumentation. (TTT)

47532 (NP-18317) CONTRIBUTIONS TO THE DESIGN AND DEVELOPMENT OF ELECTRON LINEAR ACCELERATORS. (Institutul de Fizica Atomica, Bucharest (Romania)). 1969. 234p. (In French). (AL-1/1969). Dep. CFSTI (U. S. Sales Only).

Work on the design and development of electron linear accelerators carried out by various authors at the Institute of Atomic Physics is presented. Included are the 3-MeV electron linear accelerator, calculations for the structure of the 3-MeV electron linear accelerator, technology of the accelerator guide, variable mode transitions, the Teflon joint, power load in the S band, modulation of the magnetron, and the electron gun. Injection modulation, the focusing system for the linear accelerator, the quadrupole magnet system for the 3-MeV electron linear accelerator, the electronic system for the programming of beam parameters, and the accelerator control system are discussed. Also included are the ferrite torus transducer for measuring the beam momentum, a device for studying the current density distribution in the electron beam, determination of the phase and group velocity of electromagnetic waves in the iris guide, the perturbation method for measuring the relative amplitude of the accelerator electric field, and an experimental study of the characteristics of the accelerator operation. (J.F.P.)

47533 (NP-18336) ANNUAL REPORT, 1969. (European Organization for Nuclear Research, Geneva (Switzerland)). 184p.

CERN SYNCHROTRON — development and research, 1969
DATA PROCESSING SYSTEMS — development at CERN, 1969
HIGH-ENERGY PHYSICS — research at CERN, 1969
NUCLEAR PHYSICS — research at CERN, 1969
RADIATION DETECTORS, BUBBLE CHAMBER — development at CERN, 1969
STORAGE RINGS — development of ISR, 1969
SYNCHROCYCLOTRONS — development and research at CERN, 1969
SYNCHROTRONS — development of CERN 300-GeV, status of (W.H.K.)

47534 (RHEL/R-191) THE WORK OF THE RUTHERFORD LABORATORY, 1969. Banford, A. P.; Telling, F. M. (eds.) (Rutherford High Energy Lab., Chilton (England)). May 1970. 192p. Dep. CFSTI (U. S. Sales Only).

COMPUTERS — development and research at Rutherford, 1969
HARWELL SYNCHROTRON (NIMROD) — development and operation, 1969
HIGH-ENERGY PHYSICS — research at Rutherford, 1969
INSTRUMENTS — development at Rutherford for high-energy physics, 1969
LINEAR ACCELERATORS — research at Rutherford PLA
NUCLEAR PHYSICS — research at Rutherford, 1969
RADIATION DETECTORS, BUBBLE CHAMBER — development at Rutherford, 1969
RADIATION DETECTORS, SPARK CHAMBERS — development at Rutherford, 1969 (W.H.K.)

47535 MULTI-SAMPLE LIQUID HELIUM CRYOSTAT FOR ELECTRON DAMAGE LUMINESCENCE STUDIES. Bryant, F. J.; Radford, C. J. Cryogenics; 10: 329-31(Aug 1970).

The controlled production of damage in solids by electron irradiation may be monitored using photoluminescence or cathodoluminescence techniques. Such an instrument is described in

which movement of the sample was eliminated, so that pre-damage and post-damage measurements were compared, by mounting the liquid helium cryostat on the electron drift tube of the Van de Graaf electron accelerator. The cryostat shared a common vacuum ($\leq 10^{-6}$ torr) with the accelerator and was evacuated through the electron irradiation port, connected to the drift tube of the accelerator. A number of samples were mounted in the cryostat, so that they could all be studied at low temperature without the necessity of warming the cryostat or breaking the vacuum in the cryostat. This cryostat has already been used for radiation damage studies of the luminescence properties of cadmium telluride and cadmium sulphide. (UK)

47536 CREATION AND STUDY OF IMPLANTED TARGETS FOR THE T(d,n) REACTION. Strizhak, V. I.; Primenko, G. I.; Pronman, I. M. At. Energ. (USSR); 28: 251-2(Mar 1970). (In Russian).

With prolonged bombardment of tritium–zirconium and tritium–titanium targets by deuterons the neutron yield from the T(d,n) reaction decreases with time, and the neutron yield from the D (d,n) reaction increases with time because of replacement of part of the tritium in the target by deuterium. Implanted tritium targets of titanium, chromium, copper, zirconium, niobium, tantalum and uranium were tested for tritium saturation and ability to yield neutrons after prolonged bombardment. The amount of tritium to saturate the target was significantly greater for U, Zr, Cr and Ti than for Cu and Nb. The neutron yields from the T(d,n) reaction per microcurie of tritium implanted at a voltage of 150 keV were found to be in neutrons/sec-microcurie: 1×10^9 for titanium on a Mo backing, 4.5×10^7 for chromium on a copper backing, 2×10^7 for copper, 2×10^7 for a zirconium disk, 4×10^6 for niobium, 1.5×10^7 for tantalum and 1.5×10^7 for uranium. The neutron yield was 1.8×10^7 for a titanium disk with adsorbed tritium. (TTT)

47537 IMPLANTED TRITIUM TARGETS MADE OF SCANDIUM, YTTRIUM, PRASEODYMIUM, NEODYMIUM, AND ERBIUM METALS. Strizhak, V. I.; Primenko, G. I.; Katsaurov, L. N.; Pronman, I. M. At. Energ. (USSR); 28: 249-51(Mar 1970). (In Russian).

The main disadvantage of zirconium or titanium targets as tritium absorbers is that the tritium is lost on bombarding the target with deuterons with a resulting increase in temperature to 300 to 400°C. The neutron yield subsequently decreases. Targets of the above rare earth metals were implanted with tritons by the use of a 100 microamp tritium current and an accelerating voltage of 120 kV. The saturation of the scandium and erbium targets with tritium atoms was a factor of 1.5 greater than for a yttrium target. The tritium content in scandium and yttrium targets heated to 400°C was about 65 to 70% of the initial amount. Under these same conditions a zirconium target would suffer a tritium loss of a factor of five. Even at 500°C a tritium–scandium target retained more than 50% of its initial tritium. The yield of neutrons obtainable from a tritium–scandium target compares favorably with the yield from zirconium– and titanium–tritium targets. The rare earth targets behave better than the zirconium or titanium targets at high surface temperatures. (TTT)

47538 EXTREMUM ESTIMATIONS OF FIELD DECREMENTS IN LINEAR PROTON ACCELERATORS WITH A SINGLE RESONATOR. Kvasha, A. I.; Lomize, L. G.; Murin, B. P. This paper was summarized in At. Energ. (USSR); 26: 374-5(Apr 1969) as paper No. 281. (In Russian).

Equations are derived for the relative drop in potential in the resonator of a linear proton accelerator for two limiting cases. To verify the relations obtained the field drop was measured in an I-100 injector of the Serpukhov synchrotron for a beam current of 80 mA. Experimental and calculated results are presented. (L.B.S.)

47539 ACCELERATION OF ELECTRONS IN A PLASMA BETATRON WITH AND WITHOUT HIGH CONDUCTION CURRENT. Bermel, W. (Univ., Bonn). Z. Phys.; 237: 345-67(1970). (In German).

A previous paper by Drees and Paul reported measurements on a plasma betatron. The study was continued using a betatron field with a vector potential taking into account the self magnetic field of a plasma current. The plasma was produced by a high frequency electric quadrupole field without an azimuthal magnetic field. The bremsstrahlung intensity of the accelerated electrons was observed as a function of gas pressure and accelerating field. The maximum energy of the electrons was 1.3 MeV compared to 1.5 MeV given by the field parameters. The maximum number in this energy range was about 10^{10} per pulse corresponding to a circulating runaway current of ~1 A. The conduction current was drastically reduced by coating the inner wall of the quartz glass torus with a thin layer of graphite. This change in the plasma current did not influence the γ radiation intensity. (auth)

47540 MEASUREMENT OF MISALIGNMENT OF THE AXIS OF A MAGNETIC FIELD FOR ELECTRON-BEAM FOCUSING. Nishihara, H.; Terada, M. (Osaka Univ.). J. Appl. Phys.; 41: 3322-4(Jul 1970).

The method, which was previously proposed by the authors, of locating the magnetic-field axis has been applied to measure the misalignment of the axes of a uniform magnetic field produced by a solenoidal coil and of a periodic one produced by a permanent-magnet stack. In the former the tilt of field axis has been detected with a resolution of the order of 10^{-3} rad. In the latter the displacement of the field axis has been detected with a resolution of the order of 10^{-2} mm, which is equal to about one part in 10^3 of the inner diameter of magnets. It has been found experimentally that even a slight local misalignment considerably influences electron-beam transmission. (auth)

47541 FACILITY FOR CHARGED PHOTOPARTICLE EXPERIMENTS. Keller, N. K.; Lee, J. K. P.; McConnell, D. B. (Univ. of Toronto). Can. J. Phys.; 47: 611-15(15 Mar 1969).

A low-background experimental arrangement for (γ, charged particle) reactions is described. Studies on the nature and sources of the background indicated that best results could be obtained through complete shielding, a paraffin lining in the scattering chamber, and the use of permanent magnets for electron sweeping. To demonstrate the capability of the system, a photoproton spectrum at 90° is presented for the $^{16}O(\gamma,p)^{15}N$ reaction. (auth) (Canada)

47542 PARTICLE ACCELERATION AND INTENSE ELECTRON-BEAM FRONT VELOCITIES. Rander, J. (Physics International Co., San Leandro, Calif.). Phys. Rev. Lett.; 25: 893-4(28 Sep 1970).

Ions are accelerated when a high-current relativistic electron beam is injected into a low-pressure gas-filled region. A correlation is observed between electron-beam front velocities in hydrogen and mean proton velocities that places an upper limit on the length of the acceleration region and indicates that the net beam-current rise is preceded by the protons after particle acceleration. The apparent field strengths in the acceleration region are $\geq$(3 to 6) $\times 10^7$ V/m. (auth)

47543 PHYSICAL STUDY OF THE TARGET OF AN ELECTRONUCLEAR NEUTRON FLUX GENERATOR. Bol'shov, V. I.; Dubinin, A. A.; Dmitriev, V. M.; (and others). At. Energ. (USSR); 28: 388-92(May 1970). (In Russian).

The possibility of increasing thermal neutron fluxes by means of the prompt generation of neutrons as a result of the interaction of nucleons was studied. Results of such experiments involving interaction with nucleons possessing energies of several hundred MeV with heavy nuclei are reported describing the neutron-physics characteristics of targets of electronuclear devices used to generate neutron fluxes. The synchro-cyclotron of the Joint Institute for Nuclear Studies with proton energies of 660 MeV was used for the experiments. The proton flux directed on the lead target was measured by the $Bi(n,f)$; $^{238}U(n,f)$ and $^{27}Al(p,3pn)^{24}Na$ reactions. The subcadmium neutron flux for a 1 proton/sec current was found to be 1.8×10^{-2} n/cm^2·sec. The spatial and energy distribution of the neutron flux in the zirconium hydride and deuteride ($ZrH_{1.8}$ and $ZrD_{1.9}$) and beryllium moderators was studied by using axial and circular sources; changing from the first to the second source while keeping the proton beam constant resulted in a decrease of the specific heat released in the target. The beryllium was found to possess the best nuclear physical properties, yielding a maximum neutron flux of 1.7×10^{17} n/cm^2·sec for 100 mA current in the proton accelerator. The half-lives and thermal cross sections of the ^{240}Pu, ^{245}Am, ^{246}Am, ^{247}Am, ^{251}Cm, ^{252}Cm, ^{251}Bk, and ^{252}Bk were estimated on the basis of the available data. The high neutron fluxes are very effective for preparing heavy isotopes of transuranium elements. (TTT)

47544 NEW PERFORMANCE OF THE 300 GeV ACCELERATOR. Ekspong, Goesta. Forsk. Framsteg; No. 4, 8-10(1970). (In Swedish).

Some aspects are given on the planned European 300 GeV accelerator regarding modifications that can be done at a time when superconducting magnets are available for use in such applications. (Sweden)

47545 CALCULATION OF THE LONG-LIVED INDUCED ACTIVITY IN SOIL PRODUCED BY 200-MeV PROTONS. Gabriel, T. A. (Oak Ridge National Lab., Tenn.). Nucl. Appl. Technol.; 9: 605-14(Oct 1970).

Calculations have been carried out to obtain the time and spatial

dependence of the long-lived induced activity in soil produced by 200-MeV protons incident on a small cylinder of graphite buried in soil. Only radioactive nuclei with half-lives greater than or equal to that of ^{7}Be (0.147 year) were considered. Monte Carlo methods were applied to determine the induced neutron flux which was combined with both calculated and experimental radiochemical cross sections to determine the rate of residual-nuclei production. Through the use of the results of the calculations, a procedure has been established whereby the approximate contribution of each target nucleus to the production of a particular radioactive nucleus can be obtained. The results of the calculations are also used to approximate the long-lived induced activity in soil when the small cylinder of graphite is embedded first in another material, such as iron, which is in turn surrounded by soil. (auth)

47546 THE CYCLOTRON, A NEW ROLE FOR AN OLD NUCLEAR PHYSICS TOOL. Bruninx, E. (Philips Research Labs., Eindhoven, Netherlands). Kerntechnik; 12: 226-8(May-Jun 1970).

The most important features of a compact, variable energy cyclotron are described. Charged particle activation, fast neutrons, radionuclide production and surface analysis are discussed as physico-chemical examples. The difference between a cyclotron and a nuclear reactor is thereby emphasized. Ion implantation and beam foil spectroscopy are briefly mentioned. (auth)

47547 THREE-SECTOR FOCUSING MAGNETIC PRISMS WITH r^{-1} FIELD. PART II. ION-OPTICAL PROPERTIES. FOCUSING OF DOUBLE-WEDGE-SHAPED CHARGED PARTICLE BEAMS. Fedoseev, E. P. (Inst. of Atomic Energy, Moscow). Kernenergie; 13: 151-6(May 1970). (In Russian).

The ion-optical properties of three-sector magnetic systems with r^{-1} field have been studied for double-wedge-shaped charged particle beams emitted from a linear source. The optimum focusing conditions for some special cases are given. An analysis shows such systems possessing essential advantages with respect to purely homogeneous or inhomogeneous fields to be fit for both mass separation and various concerns of mass analysis. (auth)

47548 STABILIZATION OF CHARGED PARTICLE BEAMS. Briggs, Richard J. (to U. S. Atomic Energy Commission). U. S. Patent 3,506,865. 14 Apr 1970. Filed 28 Jul 1967.

A charged particle beam conductive or directing apparatus is described having an electically inductive structure disposed circumjacent said beam to eliminate the tendency for beam particles to bunch (negative mass instability) by the interaction of electric charges induced in the inductive structure within the beam. (auth)

47549 SUPERCONDUCTIVE R.F. LINEAR PARTICLE ACCELERATOR SECTION HAVING A SCALLOPED TUBULAR SHAPE. Eldredge, Arnold L. (to Varian Associates). United States Patent 3,514,662. 26 May 1970. Filed 22 Dec 1967.

A superconductive microwave linear particle accelerator is disclosed. The particle accelerator structure includes a superconductive microwave accelerator section comprised of a plurality of superconductive coupled cavities arranged in a linear path and energized with microwave energy from a suitable source such as a high power klystron for accelerating charged particles passable through the microwave structure to nearly the velocity of light. The microwave accelerator structure is formed by a tube of superconductive material such as niobium or lead having its side wall scallop-contoured to define a plurality of axially spaced coupled cavity resonators for interaction with the beam passable therethrough. The accelerator structure is immersed in a cryogenic fluid such as liquid helium at approximately 2°K to render the coupled cavity structure superconductive to minimize microwave energy losses within the accelerator structure. (auth)

47550 HIGH-RESISTIVITY LIQUID RESISTANCE. Icre, Pierre (to Commissariat a l'Energie Atomique). British Patent 1,202,151. 12 Aug 1970. Priority date 13 Jan 1967, France.

A high-resistivity liquid resistance comprising a non-polar solvent having a resistivity $\geq 10^{13}\Omega$-cm and a dielectric constant ≤ 10 to which has been added an organic acid and then a base, forming a salt which is soluble in the solvent but not ionized, is described. A particular application of this liquid resistor is for voltage distribution in electrostatic accelerating tubes. (W.H.K.)

47551 BAKE OUT FOR UHV CHAMBERS IN AIR AT ATMOSPHERIC PRESSURE. Samuel, R. L. (European Organization for Nuclear Research, Geneva). Vacuum; 20: 295-6(Jul 1970).

A method was developed and is described to bake out the UHV chamber for the intersecting storage rings at CERN whereby the dead time during machine operation due to repairs or replacement of components of the vacuum system is reduced to a minimum. (UK)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 46449, 46510, 47324, 47325, 47543, 47637, 47805, and 47830.

47552 NEUTRON CONDUCTING TUBES. Maier-Leibnitz, H. (Institut Max von Laue-Paul Langevin, Grenoble, France). pp 93-103 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The relationships characterizing neutron reflection along ideal straight neutron guide tubes are summarized and extended to the cases of curved tubes and real guide tubes with imperfections. Practical aspects on the construction and use of real guide tubes are presented, including data on neutron reflectivity, associated radiation levels, and neutron polarization. (auth)

47553 GENERALIZATION AND EXTENSION OF THE ANGULAR DENSITY REPRESENTATION IN NEUTRON TRANSPORT ANALYSIS. Harms, A. A. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 1007-16(1 May 1970).

A generalization of the angular density representation, designated by the acronym NP_L, is formulated within the context of one-group neutron transport theory. The distinguishing feature of this formalism consists of the use of partial-range Legendre polynomials over arbitrary intervals of the angular variable. This NP_L formalism is subsequently examined for its orthogonality and recurrence properties. It is further shown that several widely used solution methods of one-group neutron transport theory are but special cases of this more inclusive representation. An indication of the computational usefulness of this NP_L representation is demonstrated by calculating the inverse diffusion length. Using a low-order approximation it is found that by a suitable choice of the angular segmentation, better numerical accuracy may be obtained in highly absorbing media when compared with alternative methods of comparable complexity. The NP_L formalism may be viewed as a continuation of the analytical trend which led from the P_L to the DP_L formalism. Alternatively, it may be viewed as a natural consequence of the desirability to specify angular structures specifically adapted to problems of neutron transport involving highly varying angular densities. Deep neutron penetration calculations represent one such class of problems. (auth) (Canada)

47554 MEASUREMENTS OF NEUTRON THERMALIZATION TIME CONSTANT OF LIGHT WATER BY PULSED NEUTRON METHOD. Fujino, Michihira; Sumita, Kenji (Osaka Univ.). J. Nucl. Sci. Technol. (Tokyo); 7: 277-84(Jun 1970).

The thermalization parameters of light water were measured using a pulsed neutron source and non-1/v absorbers (Cd, Gd and Sm). The pulsed neutron source utilizing the D-D reaction was placed at the center of an effectively infinite system of water poisoned with non-1/v absorbers. The time dependent capture γ-rays from these absorbers were detected by a NaI(Tl) scintillation counter. The neutron thermalization time constant of light water was determined to be 5.3 ± 0.3 μsec from the difference of the decaying reaction rates of the γ-rays, expressed as the sum of two asymptotical exponential components. The resulting value was larger than that of Möller's experiment (4.1 ± 0.4 μsec), but agreed fairly well with the theoretical value of 5.6 μsec, calculated by Hoshino based on the Nelkin model. A supplementary experiment was performed using thick neutronic filters of Cd and Ag. (auth)

47555 OPERATIONAL CHARACTERISTICS OF NEUTRON GENERATOR TARGETS. Bibby, D. M.; Oldham, G.; Ware, A. R. (Loughborough Univ. of Tech., Eng.). Nucl. Energy; 11: 68-71 (May-Jun 1970).

Neutron production from titanium tritide targets has been investigated. The fall in neutron flux with time has been shown to occur as a combination of two exponential decays each with a characteristic half life related to operational conditions. A suggested explanation for this compound decay is given. (auth) (UK)

47556 SLOW-NEUTRON SCATTERING BY MOLECULAR GASES. Lurie, Norman Alan. Ann Arbor, Mich.; Univ. of Michigan (1969). 131p.

Thesis.

Several topics on the subject of slow-neutron scattering from molecular gases are considered. The theory describing the interaction of the neutron with all the molecular degrees of freedom is reviewed with particular attention paid to the interaction with rotations of linearly symmetric molecules. Calculations of the double differential cross section are presented with a rigorous quantum mechanical treatment of rotations for several molecules. The calculations include contributions from interference scattering between atoms of the same molecule, but all intermolecular interactions are ignored. A critical review and evaluation of several approximate theories is given along with sample calculations of the cross section which are compared against the exact results. Experimental measurements are reported of the double differential cross section for gaseous hydrogen chloride at room temperature and an incident energy of 18.4 MeV for three scattering angles. These measurements provide experimental verification of the exact theory for linear molecules. A final topic investigated is the effect of separately evaluating the rotational and vibrational contributions to the cross section. Numerical calculations of the scattering law for deuteromethane without making the separation are compared against measurements, and these indicate that the separation procedure is not valid for scattering which involves exchange of one quantum of vibrational energy. (Diss. Abstr. Int., B)

47557 LOW-ENERGY NEUTRON INTERACTIONS WITH URANIUM CARBIDE. Lajeunesse, Claude. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 209p.

Thesis.

The low energy neutron double differential cross section of polycrystalline natural uranium carbide was measured for incident energies of 0.092, 0.135 and 0.159 eV. We observed an acoustic mode at 13 MeV and an isolated optical mode at 45 MeV. A normal mode analysis, based on the Born-von Karman approximation, was performed. The total cross section was also measured by a transmission experiment. The energy range covered was 0.006 to 4.5 eV. The Bragg peaks, due to coherent scattering, were resolved up to 0.05 eV. In the theoretical analysis, central and non-central interactions, up to the third nearest neighbors, were taken into account. This required a total of ten independent forces between these atoms. The problem was solved with the Blackman sampling method by choosing a total of 2,815 points in the irreducible Brillouin zone, which was equivalent to 110,592 points in the full zone. At each of these points, the eigenvalues and eigenvectors of the Born's dynamical matrix were evaluated. The thermodynamic frequency distribution was obtained from these eigenvalues. The eigenvectors were used to evaluate the polarization vector weighted frequency distributions used in the neutron scattering problem. Using the polarization vector weighted frequency distributions for carbon and uranium, the theoretical double differential inelastic scattering cross section was calculated in the incoherent approximation. At the same time, the scattering law was obtained. The theoretical double differential cross section was then broadened with the experimental resolution function. Multiple scattering contributions were also added and the results favorably compared with the experimental results. The elastic scattering was treated in the coherent approximation to account for the experimentally observed diffraction effects. Enough reciprocal lattice vectors were included to cover the whole energy range and all detector angles. The total coherent scattering cross section was also calculated up to 3.5 eV by summing up to 8,183 reciprocal lattice vectors. This cross section was added to the inelastic component obtained by integration of the scattering law over final energy and angle. Finally the known absorption cross sections were added to form the theoretical total cross section; excellent agreement with the experimental results was obtained. The calculated scattering law was submitted to the ENDF-B file to provide better data for reactor calculation. (Diss. Abstr. Int., B)

47558 THEORY OF COUPLED SPACE-TIME EFFECTS IN FAST PULSED-NEUTRON KINETICS AND TRANSPORT THEORY. Knickle, Harold N. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 201p.

Thesis.

The theory of coupled space-time effects in fast pulsed neutron kinetics and transport theory is examined. Only nonmultiplying and subcritical multiplying systems are considered. Two functionals were developed with analytic time dependence and numerical space and energy dependence to predict neutron distributions. The space and energy numerical dependence can be found from a numerical calculation of time moments by either a diffusion theory or transport theory code. The time moments themselves

add a great deal of quantitative physical information to the functionals. The value of the models is in their possible use in the design and interpretation of fast, pulsed source, experiments. Also, a time dependent numerical code was developed based on the double spherical harmonics approximation. The treatment of the spatial dependence is limited to heterogeneous slab geometry. The energy variable is treated using the multigroup method. Analytical studies of the convergence for simplified versions of the numerical equations indicate the system to be convergent. Similar analytical studies indicate the system of equations remains stable as the time step is decreased. Numerical studies have also shown the multigroup set of equations to be stable. Comparisons of the functionals with exact diffusion theory solutions have shown good agreement. Comparisons were made between the numerical DP_L solutions and some of the very scarce pulsed fast neutron assembly measurements. The calculations give a good representation of the general features displayed by the experimental measurements. Comparisons between the numerical DP_L solutions and analytical solutions are also in good agreement. (Diss. Abstr. Int., B)

47559 EIGENVALUE METHODS FOR THE TIME-DEPENDENT NEUTRON DIFFUSION. de Oliveira, Roberto Gomes. Stanford, Calif.; Stanford Univ. (1969). 137p.
Thesis.

The analysis of pulsed neutron experiments in multiplying and in nonmultiplying domains is considered. The analysis is based on the one-dimensional diffusion theory model. In one-group models, a scalar version of problems similar to those of Sturm–Liouville systems is generated; while in multigroup models, a vector version is required. An algorithm is suggested which allows the complete solution of the general scalar problem in all separable geometries of interest, for homogeneous boundary conditions. The results are the time eigenvalues and the spatial eigenfunctions. The algorithm is suitable for direct computer implementation. Examples of application are given. The multigroup problem can be solved by adequate extensions of the one-group algorithm. Since the associated operators are nonself-adjoint, the eigenvalues form in general a spectrum that has a discrete plus a continuous part. All of the discrete spectrum can be obtained using the suggested method. An example with two groups of neutrons in a three-region domain is given. Extensions to inhomogeneous equations and boundary conditions are considered. Application of the methods to other problems rather than the pulsed neutron problem is studied. The method is shown to be useful in the solution of nonlinear boundary-value problems. Pulsed neutron experiments can be analyzed as problems similar to Sturm–Liouville systems. The scalar problems are completely solved here. The vector problems are partially solved. Some progress in the mathematical theory of nonself-adjoint operators is required for the complete solution of the vector problem. (Diss. Abstr. Int., B)

47560 MIXED PROBLEMS FOR LINEAR TRANSPORT EQUATIONS FOR THE SLAB GEOMETRY. Hintz, Gerald Regis. Lafayette, Ind.; Purdue Univ. (1969). 123p.
Thesis.

Two time-dependent problems in the transport theory of neutrons are treated. The reactor for both problems is considered to be stratified in plane parallel layers. The total cross section and the expected number of neutrons produced per collision of a neutron with a nucleus are assumed to be constant inside a slab. The neutrons are assumed to be monoenergetic and to be produced isotropically. The expected neutron distribution N satisfies the linear Boltzmann equation subject to certain initial and boundary conditions. The function N depends on two independent variables: the position variable x and the variable μ which determines direction. The case of a slab of finite thickness surrounded by a perfect absorber is studied. The absorption cross section of the surrounding medium is assumed to be a constant that is not equal to the total cross section inside the slab. A non-homogeneous boundary-value problem for the slab of finite thickness is also studied. In this problem, the slab receives radiation from a time-dependent source on one of its surfaces. The intensity of this radiation increases from zero at time zero to a later time t_0', after which the intensity of the source is a function of direction only. These mixed problems are studied by means of the theory of semi-groups of bounded linear operators on a Hilbert space. The results are an extension of the work of J. Lehner and G. M. Wing. For the first problem, the spectrum of the associated transport operator is shown to consist of a finite (possibly null) set of real point spectrum plus a continuous spectrum that is an infinite, vertical strip of finite width. The solution N can be written as a finite eigenfunction series (if it exists) plus a residual term. The second problem is also solved for N. The asymptotic behavior of the solution is determined and related to results for steady-state problems in neutron transport theory and radiative transfer. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, A≤5

Refer also to abstract 47579.

47561 FINAL-STATE INTERACTION IN THE $^3H(t,\alpha)2n$ REACTION AT 90 KeV. Poutissou, R. L.; Jeremie, H. (Univ. of Montreal). Can. J. Phys.; 48: 1414-18(1 Jun 1970).

The neutron–neutron final-state interaction in the reaction $^3H(t,\alpha)2n$ was studied at an incident energy of 90 keV. An evaluation of the observed events according to current final-state interaction theories yields a value of −11 fm for a_{nn}. (auth) (Canada)

47562 CALCULATION ON NUCLEAR THREE- AND FOUR-BODY SYSTEMS WITH JASTROW-TYPE CORRELATED WAVE FUNCTIONS. Fantoni, S. (Scuola Normale Superiore, Pisa, Italy); Panattoni, L.; Rosati, S. Nuovo Cim.; 69A: 80-101 (1 Sep 1970).

The nuclear three- and four-body systems are investigated with a variational method and various nucleon–nucleon potentials. The trial wave functions used are products of a central-field wave function and a correlation factor symmetric in the interparticle distances. The results show that i) the use of a fixed-center reference frame or the center-of-mass reference frame yield very nearly the same values for the binding energies and r.m.s. radii of ^3H and ^4He and ii) the trial functions, although containing few variational parameters, allowed for accurate evaluations. Moreover it is shown that the correlations between more than three particles give a disregardable contribution to the various calculated quantities. (auth)

47563 ABSOLUTE NORMALIZATION OF NEUTRON SCATTERING CROSS SECTION DATA USING ORGANIC SCINTILLATORS AS SCATTERERS. Lindow, J. T.; Boschung, P.; Shrader, E. F. (Case Western Reserve Univ., Cleveland). Nucl. Instrum. Methods; 85: 151-4(1 Aug 1970).

An improved method for obtaining absolute neutron cross sections from time-of-flight scattering data has been developed which uses organic scintillators as scattering samples and Monte Carlo, experiment simulating techniques. (auth)

47564 D(d,p)T REACTION WITH A POLARIZED DEUTERON BEAM. Steinberg, Richard Ira. New Haven; Yale Univ. (1969). 169p.
Thesis.

The vector polarization analyzing power $D_2(\theta)$ and the tensor polarization analyzing powers $D_{33}(\theta)$ and $D_{11}(\theta)-D_{22}(\theta)$ of the D(d,p)T reaction were measured at a mean deuteron energy of 140 keV using a beam of polarized deuterons and a 100-keV-thick target of unpolarized deuterated polyethylene. Outgoing protons from the reaction were observed at eight angles in each of two orthogonal reaction planes. The tensor polarization of the beam was monitored by observation of the asymmetry $W(0°)/W(90°)$ of neutrons emitted from the $T(d,n)^4He$ reaction. The results for the vector analyzing power are in agreement with previous measurements at 100 and 200 keV and are consistent with a theoretical treatment by Rook and Goldfarb. The tensor analyzing powers are in reasonable agreement with a previous measurement at 170 keV and are again consistent with the Rook–Goldfarb treatment except for the detection of a small quintet-state contribution. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, 6≤A≤19

Refer also to abstracts 47574, 47575, and 47637.

47565 GAMMA CALIBRATION ENERGIES IN THE $^{23}Na(n,\gamma)^{24}Na$ AND $^{14}N(n,\gamma)^{15}N$ REACTIONS. Van Assche, P. H. M. (SCK-CEN, Mol, Belgium). pp 165-9 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

Starting from the H(n,γ)D capture gamma line an energy of 6396.93 ± 0.40 keV is obtained for the intense gamma ray in the $^{23}Na(n,\gamma)^{24}Na$ reaction. (auth)

47566 NEUTRON CAPTURE GAMMA-RAY STUDIES OF SILICON ISOTOPES. Blichert-Toft, P. H.; Tripathi, K. C. (Swedish Research Council's Lab., Studsvik, Sweden). pp 173-81 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Neutron capture gamma rays of silicon were studied using a Ge(Li) solid-state detector. Eighteen previously observed transitions were identified and more than 25 previously unreported transitions were observed, but all of these are not as yet firmly assigned as emitted by silicon isotopes. The neutron separation energies were found to be 8475.2 ± 0.5, 10612.3 ± 1.0 and 5591 ± 5 keV for ^{29}Si, ^{30}Si, and ^{31}Si, respectively. A single-crystal spectrometer was used to reflect the gamma beam in order to suppress the Compton background from intense higher-energy gamma rays. (auth)

47567 ENERGIES AND INTENSITIES OF GAMMA RAYS FROM SLOW NEUTRON CAPTURE IN NITROGEN. Jonsson, L.; Hardwell, R. (Chalmers Univ. of Tech., Gothenburg, Sweden). pp 199-207 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The ^{14}N(n,γ)^{15}N reaction was studied using Ge(Li) spectrometers. The principal aim was to establish this reaction as a standard for energy and intensity calibration in (n,γ) spectroscopy. (auth)

47568 GAMMA RAYS FROM THERMAL NEUTRON CAPTURE IN ^{24}Mg. Hardell, R. (Chalmers Univ. of Tech., Gothenburg, Sweden). pp 209-16 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The energies and intensities of gamma rays following thermal neutron capture in ^{24}Mg were determined with a Ge(Li) detector used in pair and anti-Compton arrangements. An internal target of enriched ^{24}Mg was used. Excitation energies and branchings from ^{25}Mg levels were determined. The reaction Q-values was found to be 7330.0 ± 1.0 keV. (auth)

47569 THERMAL NEUTRON CAPTURE GAMMA RAYS FROM ^{39}K AND ^{41}K. Skeppstedt, Oe. (Chalmers Univ. of Tech., Gothenburg, Sweden). pp 217-30 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Energies and intensities of the gamma rays following thermal neutron capture in enriched samples of ^{39}K and ^{41}K were measured using internal reactor targets and a three crystal Ge(Li) pair spectrometer and anti-Compton spectrometer. The reaction Q-values, excitation energies and decay schemes of ^{40}K and ^{42}K were deduced. (auth)

47570 STUDY OF THE CONTINUOUS SPECTRUM OF THE α PARTICLES OF THE ^{10}B(^{6}Li,α)3α REACTION (Q = 16.441 MeV) FOR INCIDENT PARTICLE ENERGIES BETWEEN 5 AND 10 MeV. Gil, Patrice; Frois, Bernard; Gruber, Gernot; Heinicke, Erhard; Marquez, Luis; Paviot, Nicole (Bordeaux Univ.). Compt. Rend., Ser. B.; 270: 977-80(13 Apr 1970). (In French).

A resonance at the Coulomb potential barrier was revealed in the excitation function of the continuum. This result is compatible with the hypothesis of the formation of the ^{6}Li-^{10}B quasi-molecular state. (auth) (France)

47571 STUDY OF THE EXCITED LEVELS OF ^{13}N BETWEEN 20 AND 30 MeV, THROUGH THE ^{10}B(^{3}He,α) AND ^{12}C(p,p) REACTIONS. Girod, M.; Nguyen Van Sen; Longequeue, J. P.; Tsan Ung Chan (Univ., Grenoble, France). J. Phys. (Paris); 31: 125-30(Feb-Mar 1970). (In French).

A diagram of 20-30 MeV excited levels of ^{13}N is deduced from a combined study of the ^{10}B(^{3}He,α)^{9}B reaction between 1 and 10 MeV, and of the elastic scattering ^{12}C(p,p) between 19 and 30 MeV. The Humbiet-Rosenfeld theory and the optical model + resonance formalism were used. (auth) (France)

47572 Li + d NUCLEAR REACTION. Saxena, M. K. (Univ. of Lucknow, India). Proc. Indian Acad. Sci., Sect. A; 71: 9-15 (Jan 1970).

The ^{7}Li(d,n)^{8}Be reaction was studied in order to gain information on the energy levels of ^{8}Be. The Q-values and neutron angular distributions were measured at a deuteron energy of 500 keV using the nuclear emulsion method. Evidence was found for levels in ^{8}Be at 2.0, 2.8, 3.7, 4.3, 6.0, and 7.0 MeV. These findings disagree with most of the previously published data. (J.W.R.)

47573 STUDY OF THE BOUND STATES OF ^{15}O AND A STUDY OF T = 3/2 STATES IN ^{13}C, ^{17}O, AND ^{21}Ne. Hensley, David Cecil. Pasadena, Calif.; California Inst. of Tech. (1969). 248p.

Thesis.

The bound states of ^{15}O were studied in the ^{16}O(^{3}He,α)^{15}O reaction, and the binding energy of the 6th excited state of ^{15}O with respect to ^{14}N + p was measured with special care, for astrophysical reasons. In addition, T = 3/2 states in ^{13}C, ^{17}O, and ^{21}Ne were studied in the (^{3}He,p) reaction on ^{11}B, ^{15}N, and ^{19}F and in the (^{3}He,α) reaction on ^{14}C, ^{18}O, and ^{22}Ne. In all cases, the reaction products were analyzed with a 61-cm radius, double-focusing magnetic spectrometer and detected by a 16-counter array in the focal plane of the spectrometer. The results for the four nuclei studied are summarized below. ^{15}O: the spins and parities of all of the bound states of ^{15}O were either determined for the first time or confirmed. The 6th excited state has $J^{\pi} = 7/2^{+}$ and lies 21.2 ± 0.6 keV below the ^{14}N + p threshold; the 5th excited state has $J^{\pi} = 5/2^{+}$. A correction of −4.6 ± 0.6 keV to the previously accepted mass excess of ^{15}O was determined; the new mass excess of ^{15}O is 2855.3 ± 0.6 keV. On the basis of this work, it is shown that the 6th excited state of ^{15}O has a negligible effect on the stellar rate of the ^{14}N(p,γ)^{15}O reaction. ^{13}C: four T = 3/2 states were identified in ^{13}C at the following excitation energies (spin and parity are included, where determined): 15105 ± 3 keV ($3/2^{-}$); 18655 ± 10 keV; 18692 ± 15 keV; and 19122 ± 5 keV ($\leq 7/2^{-}$). The 15.10-MeV state has a width, Γ ≤ 6 keV. ^{17}O: seven T = 3/2 states were identified in ^{17}O at the following excitation energies: 11076 ± 4 keV ($1/2^{-}$); 12467 ± 4 keV ($5/2^{-}$); 12947 ± 5 keV ($1/2^{+}$); 12994 ± 5 keV ($5/2^{-}$); 13636 ± 4 keV ($5/2^{+}$ or $3/2^{+}$); 14210 ± 10 keV; and 14243 ± 10 keV. ^{21}Ne: five T = 3/2 states were identified in ^{21}Ne at the following excitation energies: 8856 ± 6 keV ($5/2^{+}$ or $3/2^{+}$); 9136 ± 6 keV ($1/2^{+}$); 9962 ± 6 keV ($1/2^{-}$ or $3/2^{-}$); 10602 ± 10 keV; and 10901 ± 10 keV. Analog-state correspondences were made on the basis of relative intensities, excitation energies, and spin-parity assignments; four completed T = 3/2 quartets were established. The completed T = 3/2 quartets were then used to test the quadratic mass equation for isobaric multiplets. Within the experimental uncertainties, the lowest mass-13 and mass-17 quartets are fitted by the quadratic mass equation, but the two lowest mass-21 quartets deviate significantly. (Diss. Abstr. Int., B)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 46253, 46500–46502, 47573, 47637, 47670, and 47672.

47574 (NYO-3417-12) PROGRESS REPORT [ON RADIOCHEMISTRY], JUNE 1, 1969–MAY 31, 1970. Finston, Harmon L. (Brooklyn Coll., N. Y. Dept. of Chemistry). Contract AT(30-1)-3417. 18p. Dep. CFSTI.

Developments are reported for studies on: nuclear reactions of ^{12}C, ^{20}Ne, and ^{40}Ar induced by 14-MeV neutrons; thermal neutron capture cross sections of some reactor produced radionuclides; mechanism of synergic solvent extraction; and application of radioreagents. (D.H.M.)

47575 (STI/PUB-235) NEUTRON CAPTURE GAMMA-RAY SPECTROSCOPY. Proceedings Series. Proceedings of the International Symposium Held in Studsvik, Sweden, 11–15 August 1969. (International Atomic Energy Agency, Vienna (Austria)). Nov 1969. 719p. (CONF-690802). IAEA $20.00.

Sixty-seven papers and abstracts of 10 additional papers presented at the conference are included. Separate abstracts were prepared for 65 papers. Two papers were previously abstracted for NSA. For abstract numbers of these papers see CONF-690802 in the Report Number Index. (M.C.G.)

For abstracts of individual papers see: 46500–46502, 47552, 47565–47569, 47576–47620, 47639–47643, and 47667–47672.

47576 THERMAL-NEUTRON CAPTURE GAMMA-GAMMA COINCIDENCE STUDIES AND TECHNIQUES. Bolotin, H. H. (Argonne National Lab., Ill.). pp 15-34 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The advantageous use of gamma-gamma coincidence techniques in slow-neutron capture gamma spectroscopic investigations was examined and the unique information derived from such studies was compared with that obtained by more conventional spectroscopic methods. The feasibility, practicality, and value of gamma-gamma coincidence studies performed with the exclusive use of Ge(Li) detectors are clearly demonstrated. It is shown that the clarity of the data and the unequivocal information gleaned from the use of this technique are clearly superior to previously employed NaI(Tl)–Ge(Li) coincidence systems. Salient details of the method are described. Several examples of data obtained with the use of the Ge(Li)–Ge(Li) coincidence method are presented. It was concluded that widespread use of these coincidence techniques should provide a significant contribution to the understanding of the level structure of nuclides studied in slow-neutron capture gamma reaction experiments. (auth)

47577 HIGH-PRECISION NEUTRON CAPTURE GAMMA-RAY SPECTROSCOPY USING GERMANIUM DETECTORS IN COMPTON-SUPPRESSION TECHNIQUE. Michaelis, W.; Horsch, F. (Kernforschungszentrum, Karlsruhe, Ger.). pp 35-50 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The use of lithium-drifted germanium detectors in Compton-suppression technique will play a very important role in future neutron capture gamma spectroscopy. Over a broad range of energy these devices are superior to all other instruments. High-precision measurements require a favorable peak-to-background ratio and reliable methods in spectrum stabilization, spectrum analysis, calibration and nonlinearity correction. Procedures that are applied at Karlsruhe are reported and some results are given to demonstrate the efficiency of this technique. Conclusions are drawn on the future potential in neutron capture spectroscopy. (auth)

47578 PLANS FOR HIGH-RESOLUTION (n,γ) STUDIES AT THE RILL. Schult, O. W. B.; Koch, H. R.; Maier, B. P. K. (Technisch Hoshschule, Munich). pp 89-92 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

The measurement of slow neutron capture gamma spectra at the RILL will be carried out with different instruments located at both ends of a tangential through hole. The low-energy spectrum will be measured with four curved-crystal spectrometers with focal lengths from 5.8 to 24 m. The high-energy spectrum will be recorded with a Ge(Li) spectrometer. Medium-energy gamma rays will be detected with a Ge(Li) diode combined with a curved crystal monochromator and operated in the anti-Compton mode. (auth)

47579 SPECTROMETRY OF PHOTONS EMITTED BY REACTIONS INDUCED BY FAST NEUTRONS ON VARIOUS ELEMENTS. Haouat, G.; Lachkar, J.; Patin, Y.; Sigaud, J. (CEA, Paris). pp 119-22 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

A spectrometer used for the study of photons emitted by fast neutron reactions is described and some experimental data are given for Fe, ^{10}B, and W. (auth)

47580 ENERGY LEVELS IN ^{156}Gd. Baecklin, A. (Swedish Research Council's Lab., Studsvik, Sweden. Uppsala Univ.); Fogelberg, B.; Hedin, G.; Saraceno, M.; Greenwood, R. C.; Reich, C. W.; Koch, H. R.; Baader, H. A.; Breitig, H. D.; Schult, O. W. B. pp 147-54 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The reaction ^{155}Gd(n,γ)^{156}Gd was studied at high resolution by measuring the internal conversion spectrum and the gamma spectrum. In a preliminary analysis members were found of 4 positive parity bands and 7 negative parity states belonging to at least two bands. Some characteristics of these bands are discussed. (auth)

47581 A K = 2$^+$ BAND IN ^{178}Hf. Fogelberg, B.; Baecklin, A. (Uppsala Univ. Swedish Research Council's Lab., Studsvik, Sweden). pp 155-60 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The gamma spectrum and the conversion electron spectrum in the 1-MeV region from ^{177}Hf(n,γ)^{178}Hf were studied. From these data five members of a K = 2$^+$ band, which may be identified as the gamma-vibrational band, were found. Confirmation of the levels was obtained from a γ–γ coincidence measurement. From the measured branching ratios a value of the band-mixing parameter Z_2 was deduced and this quantity is compared with different theoretical estimates. (auth)

47582 (n,γ) AND (n,e$^-$) INVESTIGATION OF THE ^{177}Lu LEVEL STRUCTURE. Manfrass, P. (Central Inst. for Nuclear Research, Rossendorf, Ger.); Prade, H.; Stary, F.; Beitins, M.; Kramer, N.; Prokoviev, P. pp 161-2 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The different γ–γ coincidence measurements yielded probable spin values of the states directly excited from the capture state. A table is given of the high-energy γ spectrum of the ^{176}Lu(n,γ)^{177}Lu reaction. (M.C.G.)

47583 THERMAL NEUTRON CAPTURE GAMMA-RAY STUDIES OF NATURAL TITANIUM. Tripathi, K. C.; Blichert-Toft, P. H.; Boreving, S. (Chalmers Univ. of Tech., Gothenburg, Sweden). Swedish Research Council's Lab., Studsvik, Sweden). pp 183-98 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Detailed and precise measurements of the gamma rays following thermal neutron capture in natural titanium were made by means of a single flat crystal diffraction spectrometer and Ge(Li) detectors below 3.5 MeV and as direct spectra above 1.6 MeV. Many previously unreported transition energies were observed and fitted into the level schemes of ^{47}Ti, ^{48}Ti, ^{49}Ti, ^{50}Ti, and ^{51}Ti. The neutron binding energies obtained for the titanium isotopes from the transition assignments are in agreement with the values calculated from mass measurements within the experimental errors (about 2 keV). More accurate values of a number of levels in the titanium isotopes were determined as compared to earlier (d,p) measurements. (auth)

47584 GAMMA RAYS FROM THERMAL NEUTRON CAPTURE IN ^{40}Ca, ^{42}Ca, ^{43}Ca, ^{44}Ca, AND ^{46}Ca. Arnell, S. E.; Hardell, Oe.; Skeppstedt, Oe.; Wallander, E. (Chalmers Univ. of Tech., Gothenburg, Sweden). pp 231-55 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Energies and intensities of the gamma rays following thermal neutron capture in enriched samples of ^{40}Ca, ^{42}Ca, ^{43}Ca, ^{44}Ca, and ^{46}Ca were measured using internal reactor targets and a three-crystal Ge(Li) pair spectrometer and anti-Compton spectrometer. The reaction Q-values, excitation energies and absolute intensity values were deduced. Decay schemes of ^{41}Ca, ^{43}Ca, ^{44}Ca, and ^{47}Ca are given. The ^{42}Ca(n,γ)^{43}Ca and ^{42}Ca(d,p)^{43}Ca reactions are compared and found to give a good correlation between the strengths in the (d,p) and (n,γ) reactions. (auth)

47585 CIRCULAR POLARIZATION OF GAMMA RADIATION FOLLOWING CAPTURE OF POLARIZED THERMAL NEUTRONS IN ^{59}Co. Stecher-Rasmussen, F.; Kopecky, J.; Abrahams, K. (Reactor Centrum Nederland, Petten, Netherlands). pp 261-5 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The circular polarization of gamma radiation after capture of polarized thermal neutrons in ^{59}Co was studied with a Ge(Li) spectrometer. The results are in general agreement with previous measurements. The levels at 505 and 785 keV are discussed in some detail. (auth)

47586 THERMAL NEUTRON CAPTURE GAMMA RAYS FROM ^{61}Ni. Samama, R.; Girard, J.; Babinet, R.; Audias, A.; Gardien, J. J. (CEN, Saclay, France). pp 267-72 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Gamma rays following thermal neutron capture by ^{60}Ni were

investigated with a pair and anti-Compton spectrometer using a coaxial-type Ge(Li) detector. The region from 2 to 5 MeV in which 15 transitions not reported previously were observed was of special interest. (auth)

47587 SHELL MODEL CONFIGURATIONS IN EVEN SPHERICAL NUCLEI. Fanger, U.; Gaeta, R.; Michaelis, W.; Ottmar, H.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 273-87 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Latest results of thermal neutron capture gamma investigations of ^{62}Ni are reported. Enriched samples of 92.11% ^{61}Ni were used as external targets at the Karlsruhe reactor FR-2. The gamma radiation was studied with a Ge(Li) anti-Compton device, a 5-crystal Ge(Li) pair spectrometer, and both a Ge(Li)-NaI coincidence and a NaI-NaI angular correlation spectrometer coupled to an on-line computer. On the basis of these measurements a considerably extended level scheme of ^{62}Ni is proposed. Several new spins were assigned. The experimental levels and transition rates are compared with results of various shell-model calculations, which reproduce the low-lying experimental ^{62}Ni states fairly well. (auth)

47588 RADIATIVE NEUTRON CAPTURE STUDIES OF NUCLEAR EXCITATIONS IN ^{68}Zn. Ottmar, H.; Ahmed, N. M.; Fanger, U.; Heck, D.; Michaelis, W.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 289-300 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Nuclear excitations in ^{68}Zn were investigated via the (n,γ) reaction on a highly enriched ^{67}Zn sample. Four different spectrometers, a Ge(Li) anti-Compton spectrometer, a Ge(Li)-4 NaI(Tl) pair spectrometer, a Ge(Li)-NaI(Tl) coincidence device and an angular correlation system, were used to establish a reliable decay scheme. (auth)

47589 THE LEVEL STRUCTURE OF ^{71}Ge. Hofmeyr, C.; Winkler, B. C.; De Villiers, J. A. M.; Malan, J. G.; Tepel, J. W. (Atomic Energy Board, Pelindaba, S. Afr.). pp 301-5 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The decay gamma rays of ^{71}Ge were observed and the neutron binding energy deduced from neutron capture in ^{70}Ge. The levels that are directly populated from the capture state were determined. The level structure of the ^{71}Ge below 1.8-MeV excitation energy was investigated by means of the ^{71}Ga(p,n)^{71}Ge and the ^{71}Ga(p,nγ)^{71}Ge reactions. (auth)

47590 GAMMA DECAY OF ^{96}Mo AND ^{98}Mo AFTER THERMAL NEUTRON CAPTURE IN ^{95}Mo AND ^{97}Mo. Heck, D.; Michaelis, W.; Ottmar, H.; Schmidt, H. (Kernforschungszentrum, Karlsruhe, Ger.). pp 309-15 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The gamma spectra following neutron capture in the odd-mass molybdenum isotopes were studied with Ge(Li) and NaI(Tl) detectors. The analysis of measured angular distributions yields detailed information on the structure of some levels. The results are compared with theoretical predictions. (auth)

47591 THE LEVEL STRUCTURE OF ^{116}In FROM THE ^{115}In(n,γ) REACTION. Fubini, A.; Giannini, M.; Ivanov, E.; Popa, M.; Prosperi, D.; Rado, V. (Laboratoria di Fisica Nucleare Applicata, Rome). pp 317-35 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The gamma spectra resulting from thermal neutron capture in natural indium were measured with lithium-drifted germanium detectors. The energies and intensities of about 320 gamma lines in the ranges from 60 to 1300 and 2100 to 6700 keV were determined. The high-energy spectrum was used to identify 19 new levels below 1100 keV. A computer code, which applies the Ritz combination method, was used to fit the energies of the low-lying excited levels. The dependence on the excitation energy of the E1 and M1 reduced widths was studied. A bump was observed for M1 transitions leading to final levels with a neutron configuration of l = 2 orbital angular momentum. This has been explained in terms of $g_{7/2} \rightarrow g_{9/2}$ spin-flip transitions. (auth)

47592 EXCITED LEVELS IN ^{139}Ba, ^{140}La, AND ^{141}Ce THROUGH THERMAL NEUTRON CAPTURE. Irigaray, J. L. (Univ., Bordeaux); Asghar, M.; Petit, G. Y.; Audias, A.; Girard, J.; Samama, R. pp 337-48 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Levels excited through thermal neutron capture in target nuclei of ^{138}Ba, ^{139}La, and ^{140}Ce were studied with a Ge(Li) diode of 120 cm^3 sensitive volume. Decay schemes are presented in which 16, 17 and 10 gamma rays from totals of 20 seen in ^{139}Ba, 45 in ^{140}La and 37 in ^{141}Ce respectively have been fitted. These level schemes take account of all the primary gamma transitions seen in each of these nuclei. The present results on the spin and parity values of various excited levels are compared with those obtained by other authors and by other methods. The values of the neutron separation energy S_n for these nuclei are determined with a high precision and their significance pointed out. An attempt was made to explain the various excited levels in the nuclei studied. (auth)

47593 STUDY OF THE REACTION ^{167}(n,γ)^{168}Er. Falkstroem-Lund, Eva (Chalmers Univ. of Tech., Gothenburg, Sweden. Swedish Research Council's Lab., Studsvik, Sweden); Baecklin, A. pp 351-4 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Gamma rays from the reaction ^{167}Er(n,γ)^{168}Er were measured between 0.5 and 2 MeV with a flat crystal diffraction monochromator combined with a Ge(Li) detector. In addition to transitions found in earlier investigations evidence was found for transitions depopulating a $K = 1^-$ band. (auth)

47594 LOW-LYING ROTATIONAL BANDS IN ^{153}Sm. Smither, R. K. (Argonne National Lab., Ill.); von Egidy, T. pp 355-8 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

A series of (n,γ) and (n,e$^-$) experiments were used to develop the level scheme of ^{153}Sm. Spin and parity assignments were made for 15 of the 25 levels below 700 keV. The ground state and nine of these levels below 300 keV are interpreted as members of three $K = 3/2$ rotational bands (two of negative parity and one of positive parity). The observed gamma branching ratios were compared with the predictions of the Nilsson model for an odd neutron coupled to a deformed core. In most cases the experimental ratios agreed with the theoretical predictions to ±10%. An attempt was made to extend this analysis to the higher levels but only limited success was achieved. (auth)

47595 DIRECTIONAL ANISOTROPY OF CAPTURE GAMMA RAYS FROM ALIGNED ^{149}Sm NUCLEI. Reddingius, E. R.; Postma, H. (Kamerlingh Onnes Lab., Leiden, Netherlands). pp 359-62 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Neutron capture gamma experiments with aligned ^{149}Sm nuclei are reported. On the basis of these experiments spin values were assigned to many levels of ^{150}Sm. (auth)

47596 INVESTIGATION OF THE ^{154}Gd LEVEL SCHEME BY THERMAL NEUTRON CAPTURE. Baader, H. A. (Technische Hochschule, Munich); Koch, H. R.; Breitig, D.; Schult, O. W. B.; Greenwood, R. C.; Reich, C. W.; Baecklin, A.; Fogelberg, B. pp 363-9 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The ^{155}Gd level scheme was investigated through the study of the ^{157}Gd(n,γ) reaction with a Ge(Li) detector and a curved-crystal spectrometer and by measurement of the ^{157}Gd(n,e$^-$) spectrum. Preliminary results on the ground-state band up to I = 6 and the gamma-vibrational band up to I = 5 are presented and discussed. (auth)

47597 ANGULAR CORRELATION MEASUREMENTS ON GAMMA-RAY CASCADES FOLLOWING THERMAL NEUTRON CAPTURE. Schmidt, H.; Heck, D. (Kernforschungszentrum, Karlsruhe, Ger.). pp 371-87 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

An experimental arrangement for angular correlation measurements on gamma cascades following thermal neutron capture, which is operated on-line to a computer, is described. All of the interesting information can be accumulated simultaneously so that the determination of a large number of angular correlations is possible. Systematic errors arising from the coincident background under the peaks and from the complex structure of the capture spectrum can be eliminated either by a two-dimensional spectrum stripping procedure or, with sufficient accuracy, by application of the double-window technique. Practicable handling of data and comprehensive controls are thus possible. The extensive set of data obtained allows the results and their mutual consistency to be checked. (auth)

47598 LEVEL STRUCTURE OF LOW-LYING EXCITED STATES OF ^{187}W. Bolotin, H. H.; McClure, D. A. (Argonne National Lab., Ill.). pp 389-402 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The low-lying excited states of ^{187}W populated by primary and secondary gamma transitions from the ^{186}W(n,γ)^{187}W thermal neutron capture reaction were studied. Ge(Li) detectors were used exclusively in both singles and coincidence gamma investigations. Coincidence investigations between high-energy (~4-5.5 MeV) and low-energy (≤1200 keV) gamma rays, as well as among the low-energy transitions have allowed a total of 74 low-energy transitions to be assigned between states up to an excitation energy of 1217 keV. Several new levels were inferred and the decay properties of all states observed were established. The observed characteristics of these states are compared with the most recent (d,p) studies and a rotational model that included Coriolis band mixing. (auth)

47599 THERMAL NEUTRON CAPTURE INVESTIGATION OF THE ^{190}Os LEVEL STRUCTURE. Boem, E.; Stelzer, K. (Johann Wolfgang Goethe Univ., Frankfurt am Main). pp 403-10 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The level structure of ^{190}Os was investigated via the reaction ^{189}Os(n,γ)^{190}Os. High-energy and low-energy singles spectra were measured with Ge(Li) detectors. Coincidence measurements were performed with a Ge(Li)-NaI combination. A level scheme is proposed. States at 912 and 1113 keV are discussed in terms of collective models. (auth)

47600 NEUTRON CAPTURE INVESTIGATION OF THE ^{192}Ir AND ^{194}Ir LEVEL STRUCTURES. Krueger, H.; Stelzer, K.; Hanle, H.; Koriath, M. (Johann Wolfgang Goethe Univ., Frankfurt am Main). pp 411-19 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The nuclei ^{192}Ir and ^{194}Ir were investigated via the reactions ^{191}Ir(n,γ)^{192}Ir and ^{193}Ir(n,γ)^{194}Ir. The high-energy spectra were measured with a Ge(Li)-NaI pair spectrometer. 121 transitions in ^{192}Ir and 102 transitions in ^{194}Ir were observed in an energy range corresponding to 1700-keV excitation energy. The neutron binding energy of ^{194}Ir is B_n = 6066.1 ± 1.5 keV. The ^{192}Ir ground-state transition that would be M2 cannot be measured. It is assumed that the transition of highest energy observed goes to the 58-keV 1^+ excited state. The neutron binding energy is then B_n = 6198.7 ± 2.0 keV. Level schemes are proposed. Low-energy spectra up to 500 keV were measured for both isotopes with Ge(Li) detectors. The ^{192}Ir high-energy spectrum was also taken using a cadmium-filtered neutron beam. Large changes in intensity compared to the spectrum taken with thermal neutrons are observed. (auth)

47601 LOW-LYING EXCITED STATES OF ^{204}Tl AND ^{206}Tl POPULATED IN THERMAL NEUTRON CAPTURE. Weitkamp, C. (Kernforschungszentrum, Karlsruhe, Ger.); Harvey, J. A.; Slaughter, G. G.; Campbell, E. C. pp 421-30 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

New level diagrams of ^{204}Tl and ^{206}Tl were deduced from thermal neutron capture measurements on isotopically enriched samples. The agreement of the ^{206}Tl level scheme with theory is poor. This is attributed to the attempt of all computations to reproduce a low-lying 1^- state for which no evidence could be found experimentally. (auth)

47602 BAND MIXING IN DEFORMED ODD-MASS NUCLEI. Michaelis, W.; Weller, F.; Ottmar, H.; Fanger, U.; Gaeta, R.; Schmidt, H. (Institut fuer Angewandte Kernphysik, Karlsruhe, Ger.). pp 469-77 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The level structure of several deformed odd-mass nuclei was studied at the Karlsruhe research reactor FR-2 using radiative capture of thermal neutrons. High-resolution measurements of the gamma spectrum were performed with a Ge(Li) anti-Compton spectrometer. The high accuracy of the data allows the application of Ritz' combination principle up to energies above 1.5 MeV. Coincidence relationships were obtained by means of a Ge(Li)-NaI(Tl) coincidence system. Detailed data are given for the transition diagram of ^{167}Er. The experiments reveal the occurrence of considerable band mixing. A theoretical treatment is presented within the framework of the unified model. The calculations take into account pair correlation, quasiparticle-phonon interaction, Coriolis coupling and rotation-vibration interaction. Various properties of the deexcitation mechanism are determined to a large extent by band mixing. Examples are given for branching ratios and partial gamma half-lives both in ^{167}Er and ^{169}Yb. (auth)

47603 GAMMA-RAY INTENSITY ANOMALY IN THE (γ,γ') REACTION. Moreh, R.; Wolf, A. (Nuclear Research Centre-Negev, Beer-Sheva, Israel). pp 483-6 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Anomalous intensity radiation was found near E_γ = 5 MeV in the resonantly scattered gamma spectra in the mass region 180 < A < 208. The origin of this intensity anomaly seems to be the same as that suggested for the well-known analog of this effect in (n,γ) and (d,pγ) spectra. (auth)

47604 STUDY OF THE ENERGY LEVELS OF ^{139}La USING NUCLEAR PHOTOEXCITATION. Moreh, R.; Nof, A. (Nuclear Research Centre-Negev, Beer-Sheva, Israel). pp 487-9 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Inelastic resonance scattering of neutron capture gamma radiation from iron was used for studying high and low-energy levels in ^{139}La. The spin and parity of the 6018-keV level was found to be $^7/_2^+$, corresponding to elastic M1 radiation. Possible spin values for four excited low-lying levels were obtained. The level parameters of the 6018-keV level in ^{139}La were measured and found to be Γ = 0.08 ± 0.02 eV, Γ_0/Γ = 0.52. (auth)

47605 RECENT RESULTS ON (γ,γ) AND (γ,γ') REACTIONS FROM NEUTRON CAPTURE GAMMA RAYS. Cesareo, R.; Giannini, M.; Oliva, P.; Prosperi, D.; Ramorino, M. C. (CNEN, Rome). pp 491-505 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The analysis of the elastic and inelastic photons following the resonance absorption of neutron capture gamma rays was successfully applied to the study of highly excited levels and low-energy level schemes. Results on the (γ,γ) and (γ,γ') reactions on ^{113}Cd, ^{205}Tl, and ^{63}Cu are reported. (auth)

47606 (γ,γ') SPECTROSCOPY OF EVEN-EVEN NUCLEI USING THE (n,γ) REACTION. Schlesinger, Y.; Szichman, H.; Hass, M.; Ben-David, G. (Israel Atomic Energy Commission, Ramat-Gan, Israel. Bar-Ilan Univ., Ramat-Gan, Israel). pp 507-10 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Monoenergetic gamma rays obtained in the (n,γ) reaction are used for photoexcitation of highly excited single nuclear levels in even–even nuclei. The de-excitation of these levels permits a study of nuclear levels in stable nuclei. The results obtained for the nuclei ^{66}Zn, ^{80}Se, ^{96}Zr, ^{120}Sn, ^{126}Te, ^{128}Te, and ^{130}Te are presented and discussed. (auth)

47607 STATISTICAL CALCULATIONS OF NEUTRON CAPTURE RADIATION. von Egidy, T. (Technische Hochschule, Munich). pp 541-50 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The capture gamma spectrum, the multiplicity, the population of the levels (isomer ratio) and the line density is calculated with a computer program using formulas for the level density and transition probability. With parameters for the level density and for the transition probability from other experiments good agreement is achieved in many cases. The number of detected lines in a spectrometer is expected to increase with about the square root of the sensitivity of a spectrometer. (auth)

47608 HIGH-ENERGY GAMMA-RAY TRANSITIONS FROM MeV NEUTRON CAPTURE IN ^{206}Pb. Bergqvist, I. (Research Inst. of National Defence, Stockholm); Lundberg, B.; Nilsson, L. pp 569-74 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Gamma spectra from neutron capture in ^{206}Pb (radiogenic lead) in the energy range 1.5 to 8.5 MeV were recorded using time-of-flight techniques. The gamma spectrometer was a NaI(Tl) crystal, 20.8 cm long and 22.6 cm in diameter. The energy variation of the cross section for high-energy gamma transitions from the capturing state to low-lying states in the residual nucleus was determined. Comparisons with calculations based on semi-direct and direct capture theories show that these processes are not sufficient to explain the magnitude of the cross section in the region of the giant dipole resonance. (auth)

47609 RADIATIVE CAPTURE OF NUCLEONS IN THE GIANT RESONANCE REGION. Longo, G.; Saporetti, F. (Comitato Nazionale Energia Nucleare, Bologna). pp 575-8 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Suggestions are made for measurements to throw light on the trend of nucleon radiative capture cross-sections in the giant resonance region. The difference between the relative contribution of direct and collective mechanisms for (p,γ) and (n,γ) reactions is brought out. (auth)

47610 SOME STATISTICAL PROPERTIES OF PARTIAL RADIATION WIDTHS IN TUNGSTEN. Murray, J.; Thomas, B. W.; Rae, E. R. (Atomic Energy Research Establishment, Harwell, Eng.). pp 579-86 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

High-resolution gamma spectra from six resonances in ^{182}W, three resonances in ^{184}W, and five resonances in ^{186}W were obtained. By using the method of maximum likelihood, the properties of the reduced widths were compared with those expected from a random distribution. There is no convincing discrepancy between the data and that expected from a random distribution. (auth)

47611 keV NEUTRON CAPTURE IN THE MASS REGION A equals 40 TO 70. Bird, J. R.; Allen, B. J.; Kenny, M. J. (Australian Atomic Energy Research Establishment, Lucas Heights). pp 587-94 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Data are presented from kilovolt neutron capture measurements on elements in the mass region A = 40 to 70. Targets with even Z show individual resonances and transitions to high spin states are observed showing the importance of p- or d-wave capture. A probable interpretation is given in terms of d-wave capture but further experimental work is required. (auth)

47612 GAMMA DECAY, INCLUDING INTENSE M1'S, IN ^{115}In(n,γ)^{116}In. Earle, E. D.; Lone, M. A.; Bartholomew, G. A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 595-9 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The gamma spectra above 4.5 MeV following resonance neutron capture in six ^{115}In resonances are reported. The correlation coefficient between gamma intensities and (d,p) spectroscopic factors is zero. M1 transitions are prominent and an average value for K_{M1} of 1.5×10^{-2} eV/MeV^4 is found. Several levels strongly populated in the (n,γ) reaction were not seen in the (d,p) experiment. (auth)

47613 USE OF AVERAGE RESONANCE CAPTURE MEASUREMENTS FOR NUCLEAR SPECTROSCOPY. Smither, R. K.; Bollinger, L. M. (Argonne National Lab., Ill.). pp 601-5 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The use of the average capture gamma spectrum as a spectroscopic tool is discussed in the light of Argonne experience. (auth)

47614 NEUTRON CAPTURE GAMMA-RAY MEASUREMENTS WITH A REACTOR-PRODUCED 2-keV NEUTRON BEAM. Greenwood, R. C.; Harlan, R. A.; Helmer, R. G.; Reich, C. W. (Idaho Nuclear Corp., Idaho Falls). pp 607-13 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Neutron capture gamma measurements with a 2-keV neutron beam obtained from the Materials Testing Reactor are discussed. The utility of this beam for neutron capture gamma spectroscopy is illustrated by considering the following three reactions: ^{181}Ta(n,γ), ^{180}Hf(n,γ), and ^{55}Mn(n,γ). (auth)

47615 LEVELS IN ^{182}Ta. Helmer, R. G.; Greenwood, R. C.; Reich, C. W. (Idaho Nuclear Corp., Idaho Falls). pp 615-24 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The level structure of ^{182}Ta was studied from measurements of the prompt gamma rays following neutron capture in ^{181}Ta, from the beta decay of ^{182}Hf, and from the decay of the 16-min isomeric state in ^{182}Ta. The capture gamma measurements were made using both thermal and 2-keV neutron beams obtained from the Materials Testing Reactor. A consistent level scheme was constructed for ^{182}Ta using these data and configuration and band assignments were made. (auth)

47616 FLUCTUATION OF PARTIAL WIDTHS FROM RESONANCE NEUTRON CAPTURE IN THE ^{141}Pr NUCLEUS. Becvar, F. (Joint Inst. of Nuclear Research, Dubna, USSR); Pospisil, J.; Telezhnikov, S. A.; Urbanec, J.; Vrzal, J. pp 651-6 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Earlier experimental data obtained from gamma spectra studies on ^{142}Pr were reanalysed. Unambiguous spin assignments for five neutron resonances in ^{141}Pr were made. The analysis of 27 partial radiation widths led to a value of $\nu = 3.56$ for 3^+ resonances and the value obtained for them in 2^+ resonances is compatible with the expected value of $\nu = 1$. (auth)

47617 GAMMA-RAY SPECTRA FROM RADIATIVE CAPTURE OF RESONANCE NEUTRONS IN ANTIMONY. Paya, D.; Lottin, A. (CEN Saclay, Gif-sur-Yvette, France). pp 657-62 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Gamma spectra from individual resonances in natural Sb + n

were measured using a Ge(Li) detector and the 45-MeV Saclay linear accelerator as a pulsed neutron source. The intensities of the strongest lines that appear in the low-energy resonances are given. (auth)

47618 STUDY OF GAMMA-RAY SPECTRA FROM THE ^{163}Dy(n,gamma)^{164}Dy REACTION ON NEUTRON RESONANCE CAPTURE. Danelyan, L. S. (Kurchatov Inst. of Atomic Energy, Moscow); Efimov, B. V.; Sotnikov, S. K.; Kardon, B.; Kiss, D.; Deres, Z.; Szabo, L. pp 663-5 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

With the use of an anticoincidence scintillation gamma spectrometer the partial radiation transitions to the rotational band levels from the ^{163}Dy(n,γ) resonance energies up to 150 eV were determined. The spins of neutron levels and the average value of the partial transitions were evaluated. (auth)

47619 GAMMA RAYS FROM NEUTRON RESONANCE CAPTURE IN Mg, Si, P, AND S. Lundberg, B.; Nystroem, G.; Bergqvist, I. (Research Inst. of National Defence, Stockholm). pp 667-73 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The gamma spectra from neutron resonance capture in Mg, Si, P, and S were measured using a NaI(Tl) scintillation spectrometer, 22.6 cm in diameter and 20.8 cm long. The resonances at 47 keV in ^{26}Mg and 30 keV in ^{33}S had previously been studied. A weak resonance in ^{32}S was observed at 42 keV, which predominantly decays through the $^3/_2^-$ level at 3.22 MeV in ^{33}S. A new resonance was also found in ^{31}P at 27 keV and for Si complex resonance structure was observed in the neutron energy range 20-80 keV. The gamma spectra were found to be dominated by a few intense gamma lines through low-lying levels in agreement with previous observations. (auth)

47620 RADIATIVE TRANSITIONS FROM NEUTRON RESONANCES OF ^{105}Pd. Coceva, C.; Corvi, F.; Giacobbe, P.; Stefanon, M.; Carraro, G. (EURATOM, Geel, Belg. CNEN, Bologna). pp 675-86 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The intensities of high-energy gamma rays following neutron capture in ^{105}Pd were determined for 15 s-wave resonances selected by time-of-flight. Eighteen transitions to low-lying levels of ^{106}Pd were observed up to an excitation energy of 3.15 MeV. Knowledge of spin and parity of all the initial states and of many final states allowed the identification of E1 and M1 transitions. The values of electric and magnetic dipole transition probabilities were deduced. Useful information was obtained about spin and parity of several final states. (auth)

47621 $d_{\frac{3}{2}}$ HOLE STATES IN SCANDIUM ISOTOPES. Johnstone, I. P. (Queen's Univ., Kingston, Ont.). Can. J. Phys.; 48: 1208-13(15 May 1970).

Hole states in scandium isotopes are investigated by coupling a $d_{\frac{3}{2}}$ hole to low-lying states of the neighboring titanium isotopes. Titanium wave functions are obtained by angular momentum projection from 1f2p-shell Hartree-Fock intrinsic states, and diagonalizations are carried out using the Gillet and Sanderson particle-hole interaction. The binding energies of the $^3/_2$+ states in ^{43}Sc, ^{45}Sc, and ^{47}Sc are well reproduced, as is the spacing between higher-spin levels of the K = $^3/_2$ bands, and the polarization of the titanium cores has approximately the magnitude needed to account for the long M2 lifetimes. The model fails to give any low-lying hole states in ^{44}Sc, but a calculation of spectroscopic factors does account for the absence of observable l = 2 strength below 1.6 MeV in the ^{42}Ca(^{3}He,d)^{44}Sc reaction. (auth) (Canada)

47622 STUDY OF THE REACTION ^{35}Cl(n,γ)^{36}Cl. Hughes, L. B.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 1130-9(15 May 1970).

The gamma radiation from the ^{35}Cl(n,γ)^{36}Cl reaction was studied using a Ge(Li) spectrometer. A total of 130 gamma-ray transitions was observed with an average precision of 2 keV. The neutron separation energy was found to be 8580.6 ± 1.0 keV. An examination of the partial radiative widths revealed that the ratio of E1 to M1 radiation agreed well with the ratio obtained from other measurements of E1 and M1 transition rates but the absolute values were enhanced by a factor of 10. (auth) (Canada)

47623 COINCIDENCE MEASUREMENTS OF THE FIRST EXCITED STATE OF ^{73}Ge. Douglas, D. G. (Univ. of Manitoba, Winnipeg). Can. J. Phys.; 48: 930-4(15 Apr 1970).

A coincidence measurement of the K conversion coefficient of the 13.26-keV transition from the first excited state of ^{73}Ge yields a result closer to the E2 theoretical value than that of an earlier less-precise measurement. The half-life of the level is found to be 2.95 ± 0.05 s in agreement with one of two disagreeing previous values. (auth) (Canada)

47624 STUDY OF THERMAL NEUTRON CAPTURE IN POTASSIUM. Johnson, L. V.; Kennett, T. J. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 1109-29(15 May 1970).

The ^{39}K(n,γ)^{40}K reaction was studied using a Ge(Li) and a Ge(Li)-Ge(Li) spectrometer. A total of 252 gamma-ray transitions was observed and a gamma-gamma coincidence matrix involving 62 transitions has been established. A decay scheme based on the experimental results is deduced for 202 of the observed gamma-ray transitions. Spins and parities of some excited states were estimated from the deduced branching ratios. The neutron separation energies of the ^{40}K and ^{42}K nuclei were determined as 7800.5 ± 0.2 and 7535.2 ± 1.5 keV respectively. (auth) (Canada)

47625 INTERMEDIATE-COUPLING STRUCTURE OF ODD-A NUCLEI IN THE 2s-1d SHELL. Castel, B. (Queen's Univ., Kingston, Ont); Stewart, K. W. C.; Harvey, M. Can. J. Phys.; 48: 1490-8(15 Jun 1970).

The positive parity energy spectra of ^{29}Si, ^{31}P, and ^{35}Cl are calculated in terms of a modified intermediate-coupling model. The vibrating cores are assumed to be ^{28}Si, ^{32}S, and ^{36}Ar respectively, with the $1d_{\frac{5}{2}}$, $2s_{\frac{1}{2}}$, and $1d_{\frac{3}{2}}$ orbits available to particle and hole states. Account is taken of the anharmonicity of the two-phonon core states. The calculated energy spectra and decay schemes are in agreement with recent experimental results with parameter values consistent with previous studies in the s-d shell. (auth) (Canada)

47626 HALF-LIFE MEASUREMENTS ON ^{29}P AND ^{33}Cl. Scanlon, P. J.; Crabtree, D. (Queen's Univ., Kingston, Ont.). Can. J. Phys.; 48: 1578-84(1 Jul 1970).

The half-life values for the β^+ emitters ^{29}P and ^{33}Cl reported in the literature show a wide variation (4.6 ± 0.2 to 4.19 ± 0.02 s for ^{29}P and 2.9 ± 0.1 to 2.51 ± 0.02 s for ^{33}Cl). These activities were measured via the Si(p,γ)P and S(p,γ)Cl reactions with protons from a 3 MV Van de Graaff. The decay positrons were detected in a solid-state detector telescope and the time distribution of the pulses was determined with a multiscaler controlled by a crystal clock. Data were analyzed by an iterative least-squares procedure and by the Fourier transform method. Values obtained were 4.15 ± 0.03 s for ^{29}P and 2.47 ± 0.02 s for ^{33}Cl. (auth) (Canada)

47627 EXCITATION OF ISOMERIC ACTIVITIES IN ^{71}Ge, ^{79}Br, AND ^{79}Br USING 14.8 MeV NEUTRONS. Rurarz, E.; Haratym, Z.; Kozlowski, T.; Wojtkowska, J. (Inst. for Nuclear Research, Swierk/Otwock, Poland). Acta Phys. Pol.; B1: 97-107(Apr-Jun 1970).

The cross section for the production of the isomeric states in ^{71}Ge, ^{79}Br and ^{79}Br was measured using 14.8 MeV neutrons. The half-lives and energies of these isomeric activities were remeasured for checking the assignments. Experimental results for isomeric ratios in (n, 2n) reaction are compared with the statistical theory predictions. (auth)

47628 AUTOMATIC SYSTEM FOR MEASURING EXCITATION FUNCTIONS AT SEVERAL TENS OF keV. Bergdolt, G.; Bergdolt, A. M. (Laboratoire de Physique Nucleaire et de Physique des Accelerateurs, Strasbourg). Nucl. Instrum. Methods; 84: 205-6(1970). (In French).

A simple automatic system for measuring excitation functions is described below. The biasing of the target is done by the incident particles stopped in the target. The excitation curves are automatically normalized. (auth)

47629 ^{55}Mn(p,p'γ)^{55}Mn REACTION LOW PROTON ENERGIES. El-Zaiki, M. I.; Megalaa, W. Z.; Saad, H. R.; Youssef, A. A. (Atomic Energy Establishment, Cairo). Z. Phys.; 234: 398-404 (1970).

Angular distributions of gamma rays following the inelastic scattering of protons from ^{55}Mn were measured at proton energies below 2.50 MeV. The multipole orders for the transition 983 → 126 keV and 1,530 → 0 in ^{55}Mn were obtained. (auth)

47630 AVERAGE THERMAL NEUTRON CAPTURE CROSS SECTIONS OF ^{196}Au, ^{59}Ni, AND ^{66}Cu. Serment, V.; Abu-Samra, A.; Emmons, A. H. (Univ. of Missouri, Columbia). Nucl. Appl. Technol.; 9: 662-6(Nov 1970).

The "average thermal" neutron capture cross sections of ^{198}Au, ^{65}Ni and ^{66}Cu were measured by activation of the stable isotopes ^{197}Au, ^{64}Ni and ^{65}Cu, using γ spectrometry techniques and assuming established values for the cross sections of the stable isotopes. The samples were exposed to thermal neutron fluxes up to 2.6×10^{14} neutrons $cm^{-2}sec^{-1}$ during long times in order to obtain enough activity of the isotopes ^{199}Au, ^{65}Ni and ^{67}Cu. The values of these cross sections as determined from these activities are 28,300 barns, 24.3 barns and 145 barns, respectively. These values have a maximum error of 10%. Isotopes enriched to more than 97% were used for the Ni and Cu measurements. (auth)

47631 STUDY OF THE $^{51}V(\gamma,\alpha)^{47}Sc$ REACTION WITH 40- TO 60-MeV BREMSSTRAHLUNG BY RECOIL TECHNIQUE. Wong, Peter Alexander. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 196p.

Thesis.

The photo-alpha reaction of vanadium-51 was studied by measuring the range and the distribution of the recoil scandium-47 by the average range and a differential range method. In the differential range experiment, the aluminum stripping technique of Davies, Friesen, and McIntyre was applied. Following irradiation with bremsstrahlung energy between 40 and 65 MeV, layers of the aluminum catcher foil containing the recoil nuclei were removed. The recoil ^{47}Sc was radiochemically separated from the stripped aluminum layers, and the activities were measured using standard counting procedures. From a typical thick target and thick catcher experiment, the integral activities of the recoil ^{47}Sc in the target and in the forward, backward, and perpendicular catcher foils were measured. The average range of ^{47}Sc in the target material was determined from the experimentally measured quantities by following Winsberg's treatment of recoil data. Experimental results indicate that the reaction occurs almost entirely through the formation of an excited intermediate state of ^{51}V, followed by the evaporation of the alpha particle. The agreement between the forward-backward range and the perpendicular range is considered to be a convincing evidence for a predominantly nonpreferential distribution of recoil ^{47}Sc in the center-of-mass system. Both the energy of the alpha particle and the most probable energy of the photon absorbed by the nucleus agree well with results from other investigations in which statistical evaporation of the alpha particle is assumed. The experimental results also suggest the possibility of a contribution from a non-statistical process. The "local heating" effect suggested by Courant is proposed as a possible mechanism. When allowance is made for experimental errors, the occurrence of a non-statistical process cannot be positively confirmed. It is concluded that the extent of such a process can be assumed to be small. Therefore, the $^{51}V(\gamma,\alpha)^{47}Sc$ is a reaction which can be described mainly by the statistical model. (Diss. Abstr. Int., B)

47632 QUASI-ELASTIC SCATTERING FROM ^{40}Ca AND ^{48}Ca. Zimmerman, Peter David. Stanford, Calif.; Stanford Univ. (1969). 145p.

Thesis.

Quasi-elastic scattering is the part of the electron scattering spectrum which lies at values of the excitation energy higher than the binding energy of the least bound nucleon. In this region one or more nucleons are scattered to continuum final states. It is characterized by a structureless broad peak and, in the impulse approximation, corresponds to collisions with the individual nucleons. If the nucleons were unbound and at rest in the nucleus, the quasi-elastic peak would appear as a sharp peak at the energy loss corresponding to the free nucleon kinematics. An investigation of the quasi-elastic spectrum can provide information on the momentum distribution of the nucleons comprising the nucleus. The uncorrected measured cross sections also reflect the contributions from processes in which the electron radiates a photon while scattering, and suitable corrections must be applied to the data. A method proposed by G. Reading Henry was used to make these corrections in processes where the photon carries off more energy than the energy interval spanned by the detector. Standard methods were used to estimate the contributions due to less energetic photons. The radiative tail from the elastic peak was computed exactly. Corrected response functions were obtained at three-momentum transfer values of 250 MeV/c and 500 MeV/c. The cross sections were compared with two theoretical predictions: (1) that corresponding to a simple Fermi gas model, and (2) a more complex calculation explicitly using shell model wave functions for the nuclei. It is not possible to obtain a unique momentum distribution from the data obtained in this experiment. The results are not completely described by the predictions of the Fermi gas model. Momenta corresponding approximately to the Fermi momenta for calcium-40 and calcium-48 were obtained. The shell model calculations are not in good enough agreement with the experimental data to permit any parameters of the model to be determined. (Diss. Abstr. Int., B)

47633 EVIDENCE FOR ANGULAR MOMENTUM FRACTIONATION IN THE DECAY OF COMPOUND NUCLEI. Lyman, Warren John. Rochester, N. Y.; Univ. of Rochester (1969). 148p.

Thesis.

Experimental evidence is presented which indicates an angular momentum fractionation in the decay of compound nuclei. The laboratory angular distributions of the products ^{55,56,57,58}Co and ^{56,57}Ni resulting from reactions induced in ^{58}Ni with 37 to 61 MeV ^{4}He ions were measured. The results were compared with theoretical calculations which assumed a center-of-mass product angular distribution of the form $\omega(\phi) = 1 + b\cos^2\phi$ and a center-of-mass product velocity distribution that was either Gaussian, Maxwellian, or as predicted by simple statistical theory and calculated via a Monte Carlo technique. The product anisotropies obtained from the χ^2 fitting procedure indicate that the $^{58}Ni(\alpha,\alpha p2n)^{55}Co$ and $^{58}Ni(\alpha,\alpha pn)^{56}Co$ reactions participate in a spin fractionation process for incident ^{4}He ion energies in the range of 52 to 61 MeV. The product ^{56}Co is preferentially formed from a higher spin distribution of compound nuclei than the product ^{55}Co. A spin fractionation process is also indicated for the $^{58}Ni(\alpha,\alpha pn)^{56}Co$ and $^{58}Ni(\alpha,\alpha p)^{57}Co$ reactions for an incident ^{4}He ion energy of about 38 MeV. In this case, ^{56}Co is preferentially formed from a lower spin distribution of compound nuclei than ^{57}Co. The results for three other reactions studied ($^{58}Ni(\alpha,\alpha 2n)^{56}Ni$, $^{58}Ni(\alpha,\alpha n)^{57}Ni$, and $^{58}Ni(\alpha,\alpha 3pn)^{55}Co$) lend weight to the general rule that near the threshold for a reaction the product nuclei will preferentially be formed from a low spin portion of the total spin distribution of compound nuclei and that particle emission should therefore be nearly isotropic; when the energy involved corresponds to the high energy side of the excitation function in a region where there is competition with the reaction that emits one more nucleon, the product nuclei of the former will preferentially be formed from a high spin portion of the total spin distribution of compound nuclei, and the emitted particles will therefore have a larger anisotropy. In the reactions in which an alpha particle is emitted, the use of a Gaussian distribution of recoil velocities led to a better and generally a more reasonable fit to the measured angular distributions than the use of a Maxwellian form or the theoretically calculated spectra. In the reaction in which only neutrons and protons are emitted, the use of a Maxwellian distribution of recoil velocities gave a better and more reasonable fit than did the other two forms. A method of analysis which uses the mean square tangent of a measured product angular distribution to yield the total average energies for emitted particles, T_n, and photons, T_γ, is reviewed, and found to be inadequate for analysis of the reactions investigated. (Diss. Abstr. Int., B)

47634 NEW TECHNIQUE TO MEASURE SHORT LIFETIMES. Kuhlman, Henry Albert. Lafayette, Ind.; Purdue Univ. (1969). 100p.

Thesis.

A new technique was developed to extend the range of lifetimes measurable by the delayed coincidence method down to 10^{-12} seconds. The timing information is obtained in a conventional manner by using fast plastic scintillators and a time to amplitude converter. However, auxiliary NaI(Tl) detectors are employed to make the roles of the two plastic detectors interchangeable, thereby enabling the self-comparison method to be used on two time distributions whose centroids differ by twice the mean life of the intermediate state. To check the validity of the results of the new technique, the mean lives of the first excited state of ^{60}Ni and of ^{114}Cd were measured. The values obtained were $\tau = 1.4 \pm 0.7$ ps and $\tau = 11.4 \pm 1.0$ ps respectively, which agree with previously published results determined by different methods. The following additional mean life values were measured: $\tau = 3.8 \pm 0.4$ ps for the 889 keV level of ^{48}Ti; $\tau_1 = 38 \pm 1$ ps for the 316 keV level of ^{192}Pt; and $\tau_2 = 11 \pm 3$ ps for the 612 keV level of ^{192}Pt. (Diss. Abstr. Int., B)

47635 PERTURBED ANGULAR CORRELATION STUDIES OF MEDIUM-A NUCLEI. Heestand, Glenn Martin. Madison, Wis.; Univ. of Wisconsin (1969). 253p.

Thesis.

A perturbed angular correlations technique was used to study the interaction between excited state magnetic moments and the large hyperfine magnetic fields acting on dilute impurities imbedded in polarized Fe, Co, and Ni. Even-even isotopes of Ge, Se, Mo, Ru, Pd, Cd, and Te were Coulomb excited and implanted into polarized ferromagnetic solids by a 33–38.5 MeV oxygen beam produced by the University of Wisconsin tandem accelerator. The integral precession angle of the gamma rays decaying from the first 2+ state was measured using four NaI detectors. Systematics of the precession angles indicate that a sizable mag-

netic perturbation, called the transient field, occurs during slow down of the impurity ion. The transient field was studied using special targets and by measuring the precession angle as a function of recoil velocity for the impurity nucleus implanted into the host ferromagnetic solid. Experimental evidence indicates that this perturbation can be represented by a field on the order of 10 Mgauss but lasting less than 1 psec. Present theory indicates that the transient field is due to the scattering of polarized host electrons by the recoiling impurity ion. Combining transient field data, knowledge of internal fields, nuclear excited state lifetimes, and total precession angles enabled the extraction of 2+ magnetic moments for 25 medium A nuclei between A = 70 and A = 130. The 440 keV $5/2^-$ level of ^{77}Se was also precessed and its magnetic moment determined. Results indicate that the 2+ gyromagnetic ratios are close to the collective Z/A while the $5/2^-$ g factor for ^{77}Se follows the core-excitation model. The ion implantation perturbed angular technique (IMPACT) is discussed in detail along with transient field phenomena. Magnetic moment measurements and comparisons with theory are also discussed. (Diss. Abstr. Int., B)

47636 ABOUT NUCLEAR TEMPERATURE IN μ CAPTURE. Bobodzhanov, I. B. (Physical-Technical Inst., Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR, 12: No. 6, 20-1 (1969). (In Russian).

Nuclear temperatures for Fe, Cu, Zn, Sb, and Pb nuclei were determined at μ capture as: $T_{Fe} = 1.54 \pm 0.11$, $T_{Cu} = 1.49 \pm 0.04$, $T_{Zn} = 1.49 \pm 0.03$, $T_{Sb} = 1.22 \pm 0.03$, and $T_{Pb} = 1.02 \pm 0.04$. Nuclear temperature as a function of A was also determined. (R.V.J.)

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Refer also to abstracts 47001, 47575, 47630, 47634–47636, 47675, and 47805.

47637 (ANL–7610, pp 1–59) FISSION PROPERTIES AND CROSS SECTION DATA. (Argonne National Lab., Ill.).

From Reactor Physics Division Annual Report, July 1, 1968–June 30, 1969.

AMMONIA—neutron scattering at 295°K, time-of-flight spectra from slow, (T)
BERYLLIUM-7—electron-capture decay of, branching ratio for, (E)
BISMUTH-209—neutron elastic scattering at 0.1 to 1.6 MeV, cross section for, (E)
—neutron total cross section at 0.1 to 1.6 MeV, (E)
—neutron elastic scattering at 1.1 MeV, optical model analysis of polarization in, (E/T)
CALCIUM—neutron total cross section at 650 to 1500 keV, (E)
CALIFORNIUM-252—fission of, half-life for spontaneous, (E)
CARBON—neutron total cross section at 0.1 to 1.6 MeV, (E)
GADOLINIUM—neutron total cross section at 0.1 to 1.6 MeV, (E)
—neutron elastic and inelastic scattering at 0.1 to 1.6 MeV, total cross section for, (E)
GOLD-197—neutron elastic scattering at 0.9 MeV, optical model analysis of polarization in, (E/T)
HAFNIUM—neutron total cross section at 650 to 1500 keV, (E)
HOLMIUM-165—neutron total cross section at 0.1 to 1.6 MeV, (E)
—neutron elastic and inelastic scattering at 0.1 to 1.6 MeV, total cross section for, (E)
LEAD—neutron total cross section at 650 to 1500 keV, (E)
—neutron elastic scattering at 1.1 MeV, optical model analysis of polarization in, (E/T)
LITHIUM-6—neutron absorption by, cross section for thermal, (E)
MOLYBDENUM-100—neutron total cross section at 0.1 to 1.6 MeV, (E)
—neutron elastic scattering at 0.1 to 1.6 MeV, cross section for, (E)
NEUTRONS, DELAYED—yields from thorium-232, uranium-235, and uranium-238 fast neutron fission
PLUTONIUM-239—neutron fission at 130 to 1400 keV, cross section ratio to uranium-238 capture, (E)
—neutron fission at 40 to 100 eV, calculation of multilevel parameters using Adler–Adler method, (T)
—neutron fission at 89 to 202 eV, R-matrix single-level parameters for, (T)
RHODIUM-103—neutron total cross section at 100 to 650 keV, (E)
—neutron capture at 20 to 1400 keV, isomeric cross section ratio for, (E)
RHODIUM-104—energy levels from rhodium-103 neutron capture, low level occupation probability ratio for, (E/T)
SAMARIUM—neutron total cross section at 0.1 to 1.6 MeV, (E)
THORIUM-232—neutron elastic scattering at 0.9 MeV, optical model analysis of polarization in, (E/T)
—neutron fission at threshold to 2.4 MeV, delayed neutron yield from, (E)
—neutron fission of, energy dependence of delayed neutron yields in fast
TIN—neutron elastic scattering at 0.9 MeV, optical model analysis of polarization in, (E/T)
TITANIUM—neutron total cross section at 650 to 1500 keV, (E)
—neutron elastic scattering at 0.9 MeV, optical model analysis of polarization in, (E/T)
TUNGSTEN—neutron elastic scattering at 0.9 MeV, optical model analysis of polarization in, (E/T)
URANIUM—neutron elastic scattering at 0.9 MeV, optical model analysis of polarization in, (E/T)
URANIUM-234—alpha decay of, half-life for, (E)
URANIUM-235—neutron fission at 130 to 1400 keV, cross section ratio to uranium-238 capture, (E)
—neutron fission at 130 to 1400 keV, cross section ratio to plutonium-239 fission, (E)
—neutron fission at 250 to 1500 keV, delayed neutron yield from, (E)
—neutron fission of, energy dependence of delayed neutron yields in fast
URANIUM-238—neutron capture at 130 to 1400 keV, cross section ratios to uranium-235 and plutonium-239 fission, (E)
—neutron fission at threshold to 2.4 MeV, delayed neutron yield from, (E)
—neutron fission of, energy dependence of delayed neutron yields in fast
WATER VAPOR—neutron scattering at 593°K, time-of-flight spectra from slow, (T) (J.W.R.)

47638 (COO–1608–8) DELAYED PARTICLE SPECTROSCOPY. Final Report. Reeder, Paul L. (Washington Univ., St. Louis, Mo. Dept. of Chemistry). 31 Aug 1970. Contract AT(11-1)-1608. 25p. Dep. CFSTI.

Research with the on-line mass spectrometer at the Washington University cyclotron is described. Relative cumulative yields and relative independent yields of rubidium isotopes from fission of uranium-238 and thorium-232 induced by helium-3 and helium-4 ions were measured. Also, attempts to obtain negative ion fission products from the on-line system are described. (W.H.K.)

47639 RADIATIVE NEUTRON CAPTURE IN FISSIONABLE NUCLEI. Michaelis, W.; Leuschner, H.; Matussek, P. (Kernforschungszentrum, Karlsruhe, Ger.). pp 51–4 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB–235; CONF-690802.

Because of the great success of the (n,γ) method in nuclear structure studies, it is desirable to extend such measurements to fissionable target nuclei. A suitable spectrometer for investigating the high-energy radiative capture spectrum without significant interference from the fission process was installed at the Karlsruhe research reactor FR-2. The instrument is briefly discussed. First preliminary results are presented. (auth)

47640 CONVERSION ELECTRONS AND GAMMA RAYS FROM NEUTRON CAPTURE IN ^{235}U. Baecklin, A. (Uppsala Univ.); Fogelberg, B.; Falkstroem-Lund, Eva pp 141–5 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB–235; CONF-690802.

Conversion electrons and gamma rays following neutron capture in ^{235}U were studied. Simple methods to distinguish between lines from ^{238}U and lines from the fission products are given. Preliminary results are given for conversion electrons in the range 0.5 to 1.2 MeV. (auth)

47641 EXCITATION OF LEVELS IN ^{236}U BY THE ^{234}U$(n,\gamma)^{236}$U REACTION. Jurney, E. T. Los Alamos Scientific Lab., N. Mex.). pp 431–9 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB–235; CONF-690802.

The high and low-energy gamma spectrum from the thermal neutron capture reaction ^{234}U$(n,\gamma)^{236}$U was studied with Ge(Li) and

Si(Li) spectrometers. This work is part of an experiment involving several reactions directed toward the investigation of low-lying levels in ^{238}U. Twenty-three rotational bands were proposed. The (n,γ) data were especially helpful in distinguishing low-spin levels. (auth)

47642 5.5-MeV GAMMA-RAY ANOMALY, RECENT STUDIES. Bartholomew, G. A. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). pp 553-68 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The explanation of the 5.5-MeV gamma anomaly as radiation from the decay of 3-quasiparticle configurations is consistent with gamma strength function determinations and with experiments to excite those configurations selectively in the $^{207}Pb(p,p'\gamma)^{207}Pb$ reaction. Related experiments are reviewed. (auth)

47643 MEASUREMENTS OF PROMPT GAMMA RAYS FROM NEUTRON INTERACTION IN ^{235}U RESONANCES. Weigmann, H.; Winter, J. (EURATOM, Geel, Belg.). pp 687-91 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

A two-parameter system for measurements of capture gamma spectra from individual neutron resonances was set up at the CBNM linear accelerator. As an example, measurements of prompt gamma spectra from neutron interaction (capture as well as fission) in ^{235}U resonances are discussed. A resonance spin classification is attempted on the basis of the capture data. (auth)

47644 FINE STRUCTURE IN THE PHOTONEUTRON SPECTRA FROM ^{141}Pr AND LEAD. McNeill, K. G.; Jury, J. W.; Hewitt, J. S. (Univ. of Toronto). Can. J. Phys.; 48: 950-3(15 Apr 1970).

Careful measurements of the energy spectrum of photoneutrons ejected from praseodymium and from natural lead show that there are peaks on top of the expected smooth spectrum. Comparison with the recent cross-section studies, which indicate structure on the giant dipole resonance for these nuclei, shows agreement between the energies of the peaks found in the present work and the energies $E_n = E - Q_i$ where E corresponds to a peak in the cross-section curve and Q_i is the threshold for producing a given state in the daughter nucleus. Only ground state transitions (for Pr) or ground state and the first two excited state transitions (for Pb) need be invoked. (auth) (Canada)

47645 ELECTROMAGNETIC TRANSITION PROBABILITIES IN ^{151}Eu, ^{149}Sm, AND ^{147}Sm ISOTOPES. Kownacki, J.; Ludziejewski, J.; Moszynski, M.; Strycznewicz, K. (Inst. of Nuclear Research, Swierk/Otwock, Poland). Acta Phys. Pol.; B1: 173-85(Apr-Jun 1970).

The half-lives of some excited states in ^{151}Eu, ^{149}Sm and ^{147}Sm isotopes were measured with a time-to-amplitude converter. Radiations were detected in plastic scintillators mounted on 56-AVP photomultipliers. The E1, E2 and M1 transition probabilities between low-lying excited states are deduced. The results are compared with the predictions of the single particle and the Nilsson models. (auth)

47646 FISSION-NEUTRON MULTIPLICITY MEASUREMENTS IN THE RESOLVABLE RESONANCE REGION. Weinstein, Simon. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 126p.

Thesis.

The dependence on incident neutron energy of the fission neutron multiplicity was investigated for ^{233}U, ^{235}U, and ^{239}Pu. The results of measurements for 20 resolved resonances in ^{239}Pu below 100 eV show that the $\bar{\nu}$ values fall into two groups. The grouping is strongly correlated with the spins of the individual resonances with the J = 0 levels corresponding to high values of neutron multiplicity and the J = 1 levels corresponding to low values. The average multiplicity for the J = 0 group is 2.6% higher than the average for the J = 1 group. The observed multiplicity grouping would lead to assignments of J = 1 for the 0.298 and 23.9 eV levels, both of which were previously unassigned. No statistically significant multiplicity variation was observed in the energy range below 0.1 eV. Apparent variations in fission neutron multiplicity were observed below 10 eV among the low energy resonances of both ^{233}U and ^{238}U. The results in the energy region from 0.01 to 0.3 eV show that the multiplicity is independent of energy for ^{233}U but show a statistically significant decrease for ^{235}U in going from 0.3 to 0.01 eV. (Diss. Abstr. Int., B)

47647 K X-RAY GAMMA-RAY DIRECTIONAL CORRELATION IN THE DECAY OF ^{114m}In WITH A SUM-PEAK-COINCIDENCE SCINTILLATION SPECTROMETER. Murty, D. S.; Ramana Rao, K. V.; Jagam, P.; Lakshminarayana, V. (Saint Mary's Univ., Halifax, Nova Scotia. Andhra Univ., Visakhapatnam, India). Can. J. Phys.; 48: 1514-19(15 Jun 1970).

The evidence obtained for the existence of the K X-ray gamma-ray directional correlation by Perepelkin against the predictions of the theory of Dolginov evoked considerable interest in this field. The electron capture decay of ^{114m}In is used to advantage in the present investigation with a sum-peak-coincidence scintillation spectrometer. The results obtained are consistent with the theory of Dolginov. (auth) (Canada)

47648 ANOMALOUS LINE SHAPES IN THE INTERNAL CONVERSION ELECTRON SPECTRUM FROM ^{227}Th. Gelletly, W.; Geiger, J. S.; Merritt, J. S. (Atomic Energy of Canada, Ltd., Chalk River, Ont.). Can. J. Phys.; 48: 993-1002(15 Apr 1970).

The conversion electron spectra of the 29.9- and 31.6-keV transitions in ^{223}Ra which are excited by the α decay of ^{227}Th were studied using the Chalk River $\pi\sqrt{2}$ β spectrometer. The shapes of the L and M subshell conversion lines of the 29.9-keV transition differ significantly from those of the corresponding lines of the 31.6-keV transition. This observation confirms the difference in line shapes first reported by Valadares, Walen, and Briancon. The conversion electron spectra which are coincident with α particles which penetrated normally through the source backing were also measured. The coincidence arrangement selects the component of the conversion electron spectrum contributed by atoms recoiling freely into the spectrometer vacuum. The conversion lines of the 31.6-keV transition appear as single doppler-shifted components which are displaced toward higher momentum relative to the main peaks of the singles spectrum. The conversion lines of the 29.9-keV transition have a more complex structure. The doppler-shifted peak is less pronounced for these lines and 68 ± 10% of the intensity in these coincidence spectra appear in broad momentum distributions lying some hundreds of electron volts lower in energy than the doppler-shifted peak. These observations provide support for the explanation which Valadares, Walen, and Briancon have advanced to account for the anomalous appearance of the conversion lines of the 29.9-keV transition in their singles spectra. The coincidence spectra measured in this work together with results from the charge state studies of Perrin and de Wieclawick infer that the L (II), L (III), and M (III) binding energies in ^{223}Ra atoms of mean charge +12 are 239 ± 32, 216 ± 25, and 212 ± 38 eV higher than the corresponding binding energies in ^{223}Ra atoms of mean charge +1. (auth) (Canada)

47649 DECAY OF ^{97}Zr AND ITS DAUGHTER ^{97}Nb. Arad, B.; Prestwich, W. V.; Lopez, A. M.; Fritze, K. (McMaster Univ., Hamilton, Ont.). Can. J. Phys.; 48: 1378-85(1 Jun 1970).

The energies of the gamma lines following the β decay of the 17 h ^{97}Zr isotope and its 72 min daughter were precisely measured. With these results, the level scheme of ^{97}Nb, as derived by Siivola and Graeffe, was essentially confirmed except for minor changes and more refined energies. The level scheme of ^{97}Mo as derived by Graeffe and Siivola was modified and a few level spin and parity assignments were tentatively made. (auth) (Canada)

47650 ACTIVATION CROSS-SECTIONS FOR SOME 14.8 MeV NEUTRON-INDUCED NUCLEAR REACTIONS ON CAESIUM: ISOMER RATIOS OF ^{134}Cs, ^{133}Xe AND ^{130}I. Qaim, S. M. (Univ., Mainz). J. Inorg. Nucl. Chem.; 32: 1799-1806(Jun 1970).

Absolute cross-sections for 14.8-MeV neutron-incuded reactions on ^{133}Cs were determined using the activation technique. At this particle energy direct interaction processes also contribute. The isomer cross-section ratios σ_m/σ_g for ^{134}Cs, ^{133}Xe and ^{130}I are 0.34 ± 0.08, 0.85 ± 0.15 and 0.91 ± 0.2, respectively. A reinvestigation of the alleged $^{127}I(n, 3n)^{125}I$ reaction showed that the earlier measurement was in error. (auth) (UK)

47651 CHARGE DISTRIBUTION AND RECOIL PROPERTIES IN THE FISSION OF ^{238}U BY 11.5 GeV PROTONS. Panontin, J. A.; Porile, N. T. (Purdue Univ., Lafayette, Ind.). J. Inorg. Nucl. Chem.; 32: 1775-90(Jun 1970).

Cross sections and thick-target recoil properties were determined for a number of products in the mass region 100–115 from the interaction of ^{238}U with 11.5-GeV protons. The recoil ranges of the neutron deficient products were nearly a factor of two smaller than those of the neutron excess products, suggesting a difference in reaction mechanisms. On the basis of this finding a charge dispersion curve consisting of two separate gaussians, peaking at N/Z = 1.26 and 1.40, was constructed to fit the measured cross sections. The resulting curve is single-peaked

but has a pronounced shoulder on the neutron deficient side. The isobaric yield at A = 111 is 35.0 ± 3.5 mb and the curve associated with the neutron excess products contributes 80 per cent of the total yield. This curve is very similar to that obtained in the fission of ^{238}U by 450-MeV protons, except for a reduction in the fission cross-section by a factor of 2.4. The values of the average deposition energy, average total kinetic energy of the primary fragments, and average separation distance at scission obtained for the neutron excess fragments from their recoil properties are nearly equal to the corresponding values at 450 MeV. Many of the properties of the neutron deficient products are consistent with either spallation or fission of a nucleus in the heavy rare earth region, but neither mechanism can explain all the results. (auth) (UK)

47652 INDEPENDENT YIELDS OF ^{133}I, ^{134}I, AND ^{135}I IN THE THERMAL NEUTRON INDUCED FISSION OF ^{233}U AND ^{239}Pu: EFFECT OF THE 82-NEUTRON SHELL CLOSURE ON CHARGE DISTRIBUTION. Qaim, S. M.; Denschlag, H. O. (Univ., Mainz). J. Inorg. Nucl. Chem.; 32: 1767-73(Jun 1970).

By the rapid chemical isolation of iodine, via exchange on a preformed AgCl precipitate, the fractional independent yields of ^{133}I, ^{134}I, and ^{135}I in the thermal neutron induced fission of ^{233}U and ^{239}Pu were measured to be 0.137 ± 0.013, 0.331 ± 0.020, and 0.606 ± 0.024, respectively, for ^{233}U fission, and 0.151 ± 0.028, 0.335 ± 0.025, and 0.608 ± 0.017, respectively, for ^{239}Pu fission. The deviations quoted are standard deviations. The results are discussed in terms of the effect of the closed 82-neutron shell on charge distribution in fission; both scission of the compound nucleus into fragments and subsequent evaporation of neutrons appear to be influenced by the closed 82-neutron shell. (auth) (UK)

47653 TRANSITIONAL NUCLEI. I. DECAY OF ^{150}Pm TO LEVELS OF ^{150}Sm. Barrette, J. (Univ. of Montreal); Barrette, M.; Monaro, S.; Santhanam, S.; Markiza, S. Can. J. Phys.; 48: 1161-77(15 May 1970).

The energies and relative intensities of the γ transitions following the ^{150}Pm decay were measured using high-resolution Ge(Li) detectors. A total of 140 γ rays was observed and 117 of these transitions could be traced to 34 levels in the ^{150}Sm nucleus. A large amount of information on the structure of the ^{150}Sm nucleus could be extracted by a direct comparison of measured spectra inside and outside a well-type Ge(Li) spectrometer. In such a way sum lines arising from two (or more) coincident γ rays could be detected easily, thus giving the possibility of obtaining direct coincidence information on the ^{150}Pm decay in spite of its short half-life (2.7 h) and high complexity. Spin and parity assignments for levels in ^{150}Sm are tentatively given, by also taking advantage of previous experimental studies available on this nucleus. (auth) (Canada)

47654 EXISTENCE OF A NEW ISOMER OF HALF-LIFE 24.4 HR IN ^{156}Tb. Toriyama, Tamotsu; Fujioka, Manabu; Akiba, Mitsunori; Hisatake, Kazuo (Tokyo Inst. of Tech.). J. Phys. Soc. Jap.; 29: 9-13(Jul 1970).

A new transition of 49.630 ± 0.010 keV decaying with a half-life of 24.4 ± 1.0 hr was found in ^{156}Tb. The isotope assignment was made by the energies of L- and M-subshell internal conversions and the mass assignment by yield ratios of various Tb isotopes at different bombarding energies. The multipolarity of the transition is determined to be E1 from the L-subshell ratios. The decay scheme concerning this new transition is unknown. (auth)

47655 METHOD FOR THE HIGH PRECISION MEASUREMENT OF RELATIVE INTENSITIES AND INTERNAL CONVERSION COEFFICIENTS. Willett, J. B. (Indiana Univ., Bloomington). Contract Nonr 1705(02). Nucl. Instrum. Methods; 84: 157-67(1970).

The development of a method for the precision measurement of relative intensities and internal conversion coefficients is discussed. The success of this method primarily depends on a series of interconnecting computer analysis routines which are designed to preserve the significance of the propagated uncertainties. High precision fitting is used to determine photopeak and conversion line intensities. A pair of relative efficiency curves is derived, one for gamma rays and one for electrons, with the property that the ratio of the electron efficiency to the gamma-ray efficiency is known absolutely. Relative electron and gamma-ray intensities are determined from their respective curves and the uncertainties in the intensities are given in their complete matrix form. Internal conversion coefficients are determined directly from the absolute ratio of the two efficiency curves. Sample results are given from the analysis of the decays ^{192}Ir, ^{207}Bi and ^{137}Cs. (72 references) (auth)

47656 ISOTOPE SHIFTS IN Hf I SPECTRUM AND DEFORMATION OF EVEN NUCLEI OF HAFNIUM ISOTOPES. Cajko, J. (Nuclear Research Inst., Rez, Czech.). Z. Phys.; 234: 443-54 (1970).

Isotope shifts (IS) were studied on more than 50 spectral lines of even hafnium isotopes by means of a high resolution photoelectric Fabry–Perot spectrometer. Experimental IS constants C_{exp} were calculated from the values measured. The interpretation of the results on the basis of the isotope effect theory in the spectra of atoms with deformed nuclei made possible the determination of the intrinsic nuclear quadrupole moment of ^{174}Hf: $Q_0(^{174}Hf)$ = (7.60 ± 0.27) barn. (auth)

47657 ^{189}Os: GAMMA RAYS, LIFETIMES, AND HYPERFINE INTERACTIONS. Gregory, Mitchell Charles. Cleveland; Case Western Reserve Univ. (1968). 159p.

Thesis.

The decay of iridium-189 was studied using high resolution silicon and germanium detectors. The following gamma-ray energies and intensities were found: 25.7 (0.5), 36.3 (11.8), 56.6 (3.3), 59.2 (26.3), 69.6 (62.1), 95.3 (5.1), 138.3 (1.1), 147.1 (1.4), 149.9 (0.1), 164.0 (0.1), 180.5 (0.5), 185.9 and 188.4 (9.2), 197.4 (3.7), 206.3 (1.2), 216.8 (6.2), 219.4 (6.4), 233.4 (5.0), 244.8 (100), and 275.7 (8.8). The Mössbauer effect was observed for the 69.6- and 95.3-keV transitions at both liquid helium and liquid nitrogen temperatures. The lifetime of the 69.6-keV state was measured electronically to be 2.35 ± 0.4 nanoseconds, and the lifetime of the 95.3-keV state was determined from the Mössbauer effect as 0.19 ± 0.05 nanoseconds. Magnetic and quadrupole hyperfine structures were observed for the 69.6-keV level from which the following were observed: 1) the internal magnetic field at the osmium nucleus in iron is 1.084 ± 0.052 megagauss, 2) the magnetic moment of the excited state was found to be 0.965 ± 0.020 nm, and 3) the multipolarity admixture was measured as 0.57 ± 0.21. These results are interpreted in terms of the rotational model and are found to be in excellent agreement with this model. (Diss. Abstr. Int., B)

47658 NUCLEAR REACTION STUDIES OF ODD–ODD DEFORMED NUCLEI. Jones, Heber David. Tallahassee; Florida State Univ. (1969). 278p.

Thesis.

The energy levels of ^{174}Lu, ^{168}Tm, ^{164}Ho, and ^{158}Tb were studied by means of the (d,t) reaction. The spectra were interpreted in terms of the coupling of an odd proton and an odd neutron which occupy single-particle states described by the Nilsson model. This interpretation resulted in the determination of relative energies due to the residual neutron–proton interaction for more than thirty different configurations. In addition, the sign and magnitude of three odd-even shifts in K = 0 bands were determined. Theoretical calculations of the singlet-triplet splitting energy between the two states formed from a neutron–proton combination were made for a simple zero range spin dependent central potential. For the best choice of parameters, 17 of the 20 splitting energies calculated agreed with the corresponding experimental energies within 46 keV. The odd–even shifts, however, were not well described by the calculations. This is probably because the odd–even shift is sensitive to the space-exchange component of the neutron–proton residual interaction, which was not included in the two-body potential that was used. (Diss. Abstr. Int., B)

47659 PROPERTIES AND APPLICATIONS OF SINGLE-PARTICLE EIGENFUNCTIONS IN A DEFORMED NUCLEAR POTENTIAL WELL. Watkins, David Webster. New Haven; Yale Univ. (1969). 370p.

Thesis.

Calculation of low-lying nuclear energy levels for the odd-A nuclei ^{177}Yb, ^{183}Re, ^{167}Er, and ^{239}Pu is considered. A Hamiltonian to calculate single particles in a spheroidal Woods–Saxon potential with energy- and isospin-dependent well depth, strong spin-orbit coupling and, for protons, the Coulomb potential of a charged spheroid is presented. The Hamiltonian is diagonalized using matrix algebra. A technique is developed for imposing quadrupole and hexadecapole perturbations on the spheroidal levels. Shell corrections using the method of Strutinskii and pairing corrections from BCS theory are discussed. Equilibrium nuclear deformations for the various nuclear excitations are found by minimizing the corresponding BCS energies. It is found that the equilibrium shapes of the nuclei studied contain amounts of hexadecapole distortion different from that prescribed by the pure spheroidal shape. Computer codes with sample programs are given. (Diss. Abstr. Int., B)

47660 NEUTRON-SCATTERING MEASUREMENTS IN THE RESONANCE REGION. King, Thomas J. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 193p.

Thesis.

Neutron scattering in tungsten, rhodium, cadmium, and ^{239}Pu

was measured in the energy region below 1400 eV using two ^{6}Li glass scintillators as the neutron detectors and a 1.25 meter diameter large liquid scintillator as an anticoincidence mantle to reduce the background. The source of neutrons was the Rensselaer LINAC. Spin assignments and parameter determination were made for 7 resonances in W, 7 resonances in Rh, 5 resonances in Cd and 8 resonances in ^{239}Pu. In addition, information about the ratio Γ_n/Γ for 10 resonances in Cd (from 300 to 1400 eV) is given. Where comparisons could be made, these results are in good agreement with other experimental results. (Diss. Abstr. Int., B)

47661 (γ,xn) REACTIONS IN ^{169}Tm. Leader, John Carl. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 187p.
Thesis.

The cross sections for ^{169}Tm(γ,xn)$^{169-x}$Tm reactions were measured for $1 \leq x \leq 6$ using bremsstrahlung with end-points from 20 to 75 MeV. Cross sections were obtained by Penfold Leiss analysis of yield rates calculated from the activities induced in thulium measured with a Ge (Li) detector. Neutron energy spectra, obtained by time-of-flight measurements, were also obtained from thulium at several bremsstrahlung energies and angles. Analysis of this energy spectra data provided lower limits on the differential cross sections for neutrons arising from (γ,n) and (γ,2n) reactions. The activation experiment provided integrated cross section data on the (γ,n) and (γ,2n) cross sections, shape information on the cross sections of the (γ,3n), (γ,4n), and (γ,5n) reactions and one yield value of 75 MeV for the (γ,6n) reaction. The rising trends in the (γ,3n) and (γ,4n) cross sections after 60 MeV suggested that they might be the result of the semi-direct emission of neutrons as a consequence of the nucleon collisions following a quasi-deuteron absorption. In an attempt to test this hypothesis the results of this experiment were compared with the calculations of T. A. Gabriel and R. G. Alsmiller, Jr. on thulium. They assumed quasi-deuteron absorption followed by an internucleon cascade with the attendant particle evaporation. Comparison of their results with those of this experiment indicated that the computation predicted more evaporative cross section than was found experimentally. Although no calculations were made on the angular distribution of (γ,n) and (γ,2n) neutrons it seems unlikely that the quasi-deuteron theory would predict the extreme forward peaking found experimentally. (Diss. Abstr. Int., B)

47662 EFFECTS OF RECOILLESS EMISSION ON GAMMA-GAMMA ANGULAR CORRELATION IN ^{119}Sn. Berger, Harvey Lewis. Troy, N. Y.; Rensselaer Polytechnic Inst. (1969). 284p.
Thesis.

The degree to which extranuclear perturbations cause modification of the gamma-gamma angular correlation function $W(\theta)$ in a crystalline solid depends on the nature of the nuclear environment. It was the object of this study to relate the degree of perturbation of $W(\theta)$ to the probability of recoilless emission. A theory is presented in which it is proposed that in certain types of crystals recoilless radiation originates in regions of the sample where the perturbing fields are either small or absent. For such radiation $W(\theta)$ should be the same as the unperturbed result. Two examples of perturbing fields were treated theoretically: a static magnetic field interacting with the nucleus through the dipole moment in the intermediate state of the cascade, and a static electric field gradient V_{zz} interacting with the nuclear electric quadrupole moment Q of the intermediate state. The latter interaction proved to be more useful for purposes of experimentally studying the theoretical predictions. The 65 keV 23.8 keV gamma-gamma cascade in metallic ^{119m}Sn with an intermediate state half-life of 19 ns was experimentally studied. Angular correlations experiments were performed using high resolution coincidence circuitry in a "fast-slow" configuration. The anisotropy changed from -0.051 ± 0.030 when recoilless emission was excluded to -0.122 ± 0.027 when the recoilless emission was included as part of the detected radiation. Since measured recoilless radiation comprised only 12% of all 23.8 keV gamma rays at a source temperature of 153°K, the increase in anisotropy due to the inclusion of recoilless radiation was considerable. The theoretical anisotropy for the unperturbed case is −0.215. The results for the anisotropy of recoilless radiation, although statistically poor, are not out of line with this value. The anisotropy data were analyzed as if the entire perturbation of $W(\theta)$ and the resulting difference in the anisotropy were due to an electric quadrupole interaction. On that basis the lower limit on the interaction reducing the anisotropy of non-Moessbauer effect radiation is $eQV_{zz} = 2.5 \times 10^{-7}$ eV. The results are discussed in terms of the possible perturbations acting, and suggestions for further experiments are made. (Diss. Abstr. Int., B)

47663 GROUND-STATE QUASI-ROTATIONAL BANDS AND OTHER STATES IN EVEN NEUTRON-DEFICIENT CERIUM ISOTOPES. Smith, Gary Leroy. Davis, Calif.; Univ. of California (1969). 173p.
Thesis.

The even cerium isotopes, A = 130 to 140, were investigated in Ba(α,xnγ)Ce reactions, with x = 2, 3, 4. The energies of the gamma-rays, their relative intensities, their angular distributions relative to the beam direction, and their time distributions relative to the ~2ns FWHM beam bunch were measured. It was possible to measure half-lives of isomeric levels in the range from ~3 ns to ~200 ns. The resulting assignments show transitions from states in the ground state quasirotational band up to 8^+ in ^{138}Ce (transition energies of 253.2, 456.4, 613.9, and 729.0 keV ± 1.0 keV), up to 10^+ in ^{132}Ce (325.6, 533.5, 684.5, 789.0, and, tentatively, 875 keV ± 1.0 keV) and up to 8^+ in ^{134}Ce (409.4, 639.9, 814.8, and 948 keV ± 1.0 keV). In the three heaviest isotopes, several transitions are observed in addition to those in the ground state band. Most prominent (ground state band; others) are, for ^{136}Ce, (551.7, 761.7, 898.8; 328.6, 623.6, 664.3, and 1051.9 keV ± 1.0 keV); for ^{138}Ce, (787.9, 1037.4; 302.1, 390.7, 402.8, 417.5, 430.1, 815.0, and 977 keV ± 1.0 keV); and for ^{140}Ce (1596.7, 486.3, 202.0, 222.0, 1317.5, and 1404.1 keV ± 1.0 keV). In all but ^{138}Ce it has been possible to assign all the transitions to a level scheme. In the three lightest isotopes, all the observed transitions are in the ground state band. In ^{130}Ce, levels are assigned at 551.7 ± 1.0, 1313.4 ± 1.4, (1603.6 ± 1.4), (1937.0 ± 1.7), 1977.7 ± 1.7, (2212.2 ± 1.7), and (2265.6 ± 2.0) keV. In ^{140}Ce, levels are assigned at 1596.7 ± 1.0, 2083.0 ± 1.4, 2174.3 ± 2.0, 3491.8 ± 2.0, 3511.8 ± 2.0, and 3713.8 ± 2.0 keV. One of the most remarkable results of this work is the very smooth variation from nucleus to nucleus in the energies of the ground state quasirotational band members. This smooth trend is not only a qualitative one, but is reflected in the quantitative calculation of these transition energies by a very simple model to a precision of <1%. The results of these calculations are given. (Diss. Abstr. Int., B)

47664 EXPERIMENTAL DETERMINATION AND STATISTICAL-MODEL ANALYSES OF EXCITATION FUNCTIONS AND RECOIL ION RANGES FROM REACTIONS INDUCED IN ^{197}Au BY 19- TO 100- MeV ^{4}He IONS. Lanzafame, Frank Michael. Rochester, N. Y.; Univ. of Rochester (1969). 145p.
Thesis.

Reactions induced in ^{197}Au with 19 to 100 MeV ^{4}He ions were investigated. Excitation functions and thick target recoil ion ranges are reported for the production of ^{200}Tl, ^{199}Tl, ^{198}Tl, ^{197}Tl, ^{196}Tl, ^{195}Tl, and ^{196}Au; excitation functions are reported for the production of ^{196}Au, ^{195}Au, ^{194}Au, ^{197m}Hg, and ^{195m}Hg. The thallium excitation functions appear to be predominantly compound nuclear in the vicinity of their maxima, as evidenced by their competitive nature and the agreement of the recoil ion ranges with the theoretical predictions based on the range theory of Lindhard, Scharff, and Schiott, calculated with the assumption of full momentum transfer in the reaction. These excitation functions represent the major portion of the total reaction cross section and, for a given reaction, rise from the threshold to a maximum and then decrease with a significant high energy tail. The excitation functions for the production of ^{196}Au, ^{195}Au, and ^{194}Au appear to be predominantly the result of a non-compound process as evidenced by a lack of compound nuclear competition and the recoil ion ranges of ^{196}Au which decrease from the theoretical prediction at the threshold to about 10% of the predicted value at 100 MeV. The experimental excitation functions are compared with the results of calculations using the formalism of Griffin which considers the emission probability of a particle from an excited nucleus to be a sum of two emission probabilities; one for emission from a nucleus at statistical equilibrium, the compound emission probability, and one from the nucleus as it approaches equilibrium by a step-wise process, the precompound emission probability. This model is able to reproduce the peak and high energy tail from reactions which appear to be predominantly compound nuclear, as well as the excitation functions from predominantly non-compound processes. (Diss. Abstr. Int., B)

47665 PHOTONEUTRON AND TOTAL CROSS-SECTIONS OF ^{238}U IN GIANT RESONANCE. de Carvalho, H. G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro); Martins, J. Benuzzi; Di Napoli, V.; Margadonna, D.; Salvetti, F. Notas Fis., Cent. Brasil. Pesqui. Fis.; 15: 319-43(1969).

From the photofission cross section, from the (γ,n) cross section per equivalent quantum, measured at 1000 MeV and from the electric quadrupole moment, the total cross section of the ^{238}U for photon absorption in the giant resonance was obtained. The cross sections for (γ,n), (γ,2n), and (γ,N) processes are given. The maximum value of the σ(γ,n) is 400 mb at 11 MeV with a width Γ(γ,n) of 2 MeV. The maximum value of the σ(γ, total) first peak has a value of 470 mb at 11 MeV and the maximum of σ(γ, total) second peak has a value of 520 mb at 14 MeV. The integrated

(γ, total) cross section is 3.33 Mev-barn in good agreement with the Sum Rule of Thomas–Reiche–Kuhn. The values of nuclear symmetry energy K, obtained by two methods are 28.2 MeV and 23.6 MeV, respectively. The first is in excellent agreement with the average value of 27.4 MeV found by Bramblett et al. and the second with the 23 MeV based on Green's evaluation. The curve of $\sigma(\gamma,2n)$ is in good agreement with the theoretical curve of Weisskopf for a level density parameter of 20 MeV^{-1}. The (γ,N) cross section has a maximum value of 1236 mb at 14 MeV and a $\Gamma(\gamma,N)$ value of 6.0 MeV. (auth)

Nuclear Theory

Refer also to abstracts 47423, 47467, 47468, 47575, and 47934.

47666 (NYO–3782-4, App.5) ROLE OF COUNTERSTREAMING INSTABILITIES IN THE EARTH'S BOW SHOCK. Auer, P. L.; Kilb, R. W.; Crevier, W. (Cornell Univ., Ithaca, N. Y. Lab. of Plasma Studies). 25p.

From properties of the high beta plasma state.

The counterstreaming ion–ion instability that may operate in the plane of the Earth's bow shock is examined in order to estimate its effectiveness in the ion thermalization process. Plots of linear growth rates in two dimensions for various values of parameters corresponding to bow shock conditions are presented. Comparison with experimental data and earlier one-dimensional macro-particle calculations lead one to infer that this mode of instability does not play a dominant role in the ion thermalization process. (auth)

47667 VIBRATIONAL FIELDS AND NUCLEAR DIPOLE MODES. Bohr, A. (Univ. of Copenhagen); Mottelson, B. R. pp 3-11 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The vibrational field in isovector modes was estimated on the basis of the symmetry potential. The estimate yielded a frequency for the dipole mode in agreement with the observed photoresonance frequency in heavy nuclei. The effect of the neutron excess on the dipole modes with and without charge-exchange is also discussed. (auth)

47668 RECENT EXPERIMENTS FOR NEUTRON CAPTURE CONVERSION ELECTRONS. von Egidy, T. (Technische Hochschule, Munich). pp 127-39 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The information on the structure of the nucleus that can be obtained by measuring conversion electrons following neutron capture is discussed. The electron spectrometers in operation at Munich, Studsvik, Riga, Moscow, Leningrad, and Argonne and the one planned for the high flux reactor at Grenoble are described briefly and compared with the aid of different figures of merit. (auth)

47669 ANALYSIS AND DESCRIPTION OF NUCLEAR ROTATIONAL SPECTRA. Elbek, B. (Niels Bohr Inst., Copenhagen). pp 443-61 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The general properties of nuclear rotational spectra are discussed, first for a single nucleon in a static deformed potential, then for a real nucleus with a real rotational degree of freedom and definite total angular momentum, and finally as modified by nuclear pairing effects, Coriolis coupling and the crossing of levels of the same spin and parity ($\Delta N = 2$). Experimental illustrations of the predicted effects are given and compared to theory. (auth)

47670 CALCULATION OF ROTATIONAL STATES IN DEFORMED NUCLEI. Holmberg, P. (Univ. of Helsinki). pp 463-7 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The nucleus is considered as a nonrigid rotator. When the stretching is taken into account we arrive at the formula $E = a\{[1 + bI(I + 1)]^{\frac{1}{2}} - 1\}$ for the rotational energy. The formula can be obtained both from level systematics and from nuclear hydrodynamic considerations. A comparison of experimental and calculated values is performed for even–even ($K = 0$ bands) and odd-A ($K \geq \frac{1}{2}$ bands) nuclei in the mass region $165 \leq A \leq 190$. (auth)

47671 PRESENT THEORY OF CAPTURE. Lane, A. M. (Atomic Energy Research Establishment, Harwell, Eng.). pp 513-25 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

Present channel capture theory, based on electric dipole operators, suggests, but does not necessarily establish, the existence of some of the correlations observed between parameters occurring in thermal and resonance capture. The correlation relationships implicit in this theory are discussed, along with possible theoretical generalizations which might improve the agreement with difficult data. The question of direct capture in the resonance region is examined and the theoretical implications of the anomalous high-energy bump, which is found in the photon spectrum of neutron capture in several elements is discussed. (auth)

47672 SEARCH FOR SIMPLE CONFIGURATIONS IN THE CAPTURE STATE OF (n,γ) REACTIONS. Gersch, H.-U; Rudolph, W. (Zentralinstitut fuer Kernforschung, Rossendorf, Ger.). pp 527-39 of Neutron Capture Gamma-Ray Spectroscopy. Vienna; International Atomic Energy Agency (1969).

From International Symposium on Neutron-Capture Gamma-Ray Spectroscopy, Studsvik, Sweden. See STI/PUB-235; CONF-690802.

The influence of simple configurations contained in the capture state of various (n,γ) reactions was investigated. Comparison of the primary transition probabilities in (d,p) and (n,γ) reactions to the low-lying levels of the final nuclei showed in a few cases a dominant influence of the entrance channel on the primary gamma radiation (channel capture). However, in most cases the gamma transitions cannot be explained by the contribution of the entrance channel to the capture state. In cases where a dominant channel capture is to be expected the influence of potential capture and resonant channel capture was investigated. For this purpose estimations for both terms of the channel capture performed earlier are used. In the remaining cases a qualitative interpretation of the gamma spectra is attempted by means of other simple configurations (perhaps doorway states) in the capture state. (auth)

47673 DEPENDENCY OF THE MODEL INTERACTION POTENTIAL OF α PARTICLES FROM ENERGY FOR $E < 6$ MeV. Yanavichyus, A. (Pedagogical Inst., Siauliai, USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos; 9: 1005-8(1969). (In Russian).

The energy dependency of the model potential $V = Ae^{-\alpha x}$ is obtained. Parameters A and α are calculated from the phase shifts. The results correlate with previous results. (auth)

47674 NUCLEAR CHARGE DISPERSION IN FISSION. Khan, A. H. (Atomic Energy Centre, Dacca, Pakistan). Nucl. Sci. Appl., Ser. A; 5: 43-9(Apr 1969).

The charge dispersion phenomenon in nuclear fission in the range of thermal energy to a few hundred MeV is discussed briefly. From this review, it appears that in low-energy fission processes, the isobaric distribution of the yields of fission products against their charges is consistent with the Gaussian distribution with $c = 0.9 \pm 0.1$. In this energy region the ECD mechanism of fission is favored. In high-energy fission processes, the assumption of the symmetric distribution of independent yields of fission products as a function of their neutron-to-proton ratios is found to correlate with the experimental data very well, favoring the UCD mechanism. The effect of excitation energy on charge dispersion parameters shows that with increasing excitation energy, charge dispersion curves broaden and the most probable charge, Z_p, shifts towards beta stability. But this increase in Z_p with excitation energy is different for light- and heavy-mass fission products because of two different modes of neutron evaporation from these two sets of fission products. (auth)

47675 THE CALCULATION OF THE BETA-DECAY OBSERVABLES FOR DEFORMED NUCLEI. Behrens, H. (Univ., Karlsruhe, Ger. Kernforschungszentrums, Karlsruhe, Ger.); Bogdan, D. Nucl. Phys.; A143: 468-80(1970).

It is shown that for a correct calculation of the β-decay observables of first-forbidden transitions it is necessary to take into account rigorously the radial dependence of the electron wave functions, to consider the higher-order terms, which are usually called third-forbidden corrections, and to include the deformed part of the Coulomb potential in the case of deformed nuclei. (auth)

47676 FURTHER REMARKS CONCERNING ALPHA-PARTICLE SCATTERING. Burman, R. (Univ. of Western Australia, Perth). Int. J. Electron.; 28: 495(May 1970).

In a further letter in the correspondence on a paper by Abdelkader (NSA, 23: 21242) it is suggested that the use of the term "field" in different connotations is a matter of personal taste. It is also stated that the author's original remarks (Int. J. Electron., 26: 101(1969)) concerning the idea of an inertial frame were not answered by Abdelkader in his reply (Int. J. Electron., 26: 503(1969)). (UK)

47677 AUTHOR'S REPLY TO THE FURTHER COMMENTS OF DR. BURMAN ON HIS PAPER "AN INCONSISTENCY IN THE ANALYSIS OF ALPHA-PARTICLE SCATTERING". Abdelkader, M. A. Int. J. Electron. 28: 497-9(May 1970).

It is stated that Burman (Int. J. Electron., 28: 495(May 1970)) supports the idea that the term "field" can be used for any function that gives the force on a particle even if the velocity of the particle is involved. However it is contended that physicists do not use the term in this way but as denoting a unique physical entity which exists per se having a definite measurable value at any point of space. It is maintained that the original remarks concerning special relativity have been misunderstood. Finally the refutation of the tenets of special relativity published in 1963 (Abdelkader, M. A., J. Electron. Control. 15: 419) is repeated. (UK)

47678 PROGRESS IN NUCLEAR PHYSICS. VOLUME 11. Brink, D. M.; Mulvey, J. H. (eds.). Oxford; Pergamon Press (1970). 320p. £7.

Separate abstracts have been prepared for the six review articles contained in this publication. (UK)

For abstracts of individual sections see: 46513, 47422, and 47679–47682.

47679 NEUTRON CAPTURE γ-RAYS. Bergqvist, I. (Research Inst. of National Defence, Stockholm); Starfelt, N. Progr. Nucl. Phys.; 11: 1-51(1970).

A review is presented on the experimental and theoretical work concerning the reaction mechanism of neutron capture. Developments in experimental techniques are briefly summarized. The theory of semidirect or collective capture is discussed in detail. (80 references) (J.W.R.)

47680 NUCLEAR SPECTROSCOPY WITH HEAVY IONS. Newton, J. O. (Univ. of Manchester, Eng.). Progr. Nucl. Phys.; 11: 53-144(1970).

The status of research on heavy-ion induced nuclear reactions is surveyed. The advantages and disadvantages of heavy-ion reaction for nuclear structure studies are discussed. Research on direct reactions and (HI, XR) reactions is reviewed, and various experimental methods used in studying heavy-ion reactions are described. (195 references) (J.W.R.)

47681 STATISTICAL FLUCTUATIONS IN NUCLEAR REACTION CROSS-SECTIONS: RESULTS AND INTERPRETATION. Marcazzan, M. G. B.; Colli, L. M. (CISE, Milan). Progr. Nucl. Phys.; 11: 145-93(1970).

The subject is reviewed under the following headings: Theoretical basis of statistical fluctuations, problems in the analysis of experimental results, and experimental results on fluctuations and their analysis. It is concluded that such studies are important to the knowledge of nuclear properties particularly as regards reaction mechanisms and an insight into the compound nucleus description. The possibility of measuring the lifetime of a nucleus excited at 20 MeV or more has given important information on the level density of nuclei. It is emphasized that the possible presence of compound nucleus formation must always be kept in mind when studying reaction mechanisms, at low intermediate energies, since it has been shown that, through interference phenomena with direct mechanisms, the presence of even a little compound nucleus formation, if not recognized, can cause serious difficulty in the interpretation of reaction properties. Further desirable studies are indicated. (76 references) (UK)

47682 NUCLEAR STRUCTURE STUDIES BY (p,2p) REACTIONS. Rio, M.; Ruhla, C. (Institut de Physique Nucleaire, Orsay, France). Progr. Nucl. Phys.; 11: 195-221(1970).

After a brief historical introduction the following topics are discussed: Experimental problems in (p,2p) studies, information obtained from (p,2p) reactions, results on proton binding energies, results on binding energy spectra and angular correlation distributions for ^{6}Li and ^{7}Li, and ^{24}Mg and ^{28}Si. These examples show the usefulness of (p,2p) reactions for the investigation of nuclear inner shells and the necessity, in order to complete information on external shells, of studying pick-up reactions which are able to provide detailed spectroscopic information. (37 references) (UK)

47683 EXTENSION OF THE VARIABLE MOMENT OF INERTIA MODEL TOWARD MAGIC NUCLEI. Scharff-Goldhaber, Gertrude (Brookhaven National Lab., Upton, N. Y.); Goldhaber, Alfred S. Phys. Rev. Lett.; 24: 1349-53(15 Jun 1970).

Ground-state bands of the quadrupole type are found in even-even nuclei ranging from the most deformed to doubly magic. Their analysis indicates how an "internal stress" which tends to keep the nucleus spherical is overcome as the angular momentum increases. (auth)

47684 MEASUREMENT OF ISOMERIC YIELD RATIOS IN NUCLEAR REACTIONS. Ahumada, J.; Nassiff, S. J. Radiochim. Acta; 13: 121-31(1970).

The various cases that can occur in the experimental determination of the yield ratios of independent nuclear isomers produced by nuclear reactions are discussed. The measurements required for each case are clearly indicated. (auth)

47685 THREE-BODY CORRELATIONS IN NUCLEAR MATTER WITH PHENOMENOLOGICAL NUCLEON–NUCLEON POTENTIALS. Dahlblom, Torolf K. (Univ. of Helsinki). Acta Acad. Abo., Ser. B; 29: No. 6, 80p.(1969).

Three-body correlations are studied in the Bethe–Faddeev–Day scheme. Realistic nucleon–nucleon potentials with both hard and soft repulsive cores (the Reid potentials) are employed in the calculations. The case, where each three-body Rajaraman diagram contains an explicit tensor force in the initial and final interactions, is investigated and an expression for the energy is derived. It is found that only third-order (in the reaction matrix) diagrams are of importance in this case. A particle-state potential, which approximately cancels all three-body correlations is calculated; this potential is small for relevant values of the particle-state momentum ($3 - 4\ F^{-1}$). The value for the binding energy per particle from Reid's soft-core potentials is –0.7 MeV at the normal saturation density ($k_F = 1.36\ F^{-1}$); of this, –0.5 MeV is due to diagrams containing the explicit tensor force. It is found that the energy difference between the first terms (the bubble and ring diagrams) and the total sum of the three-body series is much larger for the hard-core than for the soft-core potentials: +7.0 MeV and +1.4 MeV, respectively, at $k_F = 1.36\ F^{-1}$. (auth) (Finland)

47686 FORM OF LIGHT EVEN–EVEN NUCLEI. Filippov, G. F.; Steshenko, A. I. (Inst. of Theoretical Physics, Kiev). Ukr. Fiz. Zh.; 15: 626-31(Apr 1970). (In Russian).

Binding energies, shapes and internal quadrupole moments of light even-even nuclei are calculated by means of a density matrix constructed on one-particle wave functions of an anisotropic oscillator by the variational method. A pair potential of the Gaussian type is assumed to act between nucleons. (auth)

47687 BETHE THEORY OF THE NUCLEAR SURFACE. Lin, Ying-chi. Ithaca, N. Y.; Cornell Univ. (1969). 176p. Thesis.

A study of the problem of the nuclear surface on the basis of the Thomas–Fermi theory of finite nuclei developed by Bethe is presented. The total energy of a nucleus is first expressed in terms of the density distribution. A variational process is then used to derive an integral equation for the density distribution. This integral equation is simplified by applying it to a semi-infinite nucleus. With this general procedure, two formulations for the problem of the nuclear surface are given. The work by Bethe and Nemeth is followed as one formulation which is characterized by the explicit inclusion of various parts in the total energy of a nucleus. Then a later formulation of the theory by Bethe is used, in which the total energy of a nucleus is arranged such as to make maximum use of nuclear matter theory, and at the same time to simplify the structure of the result and integral equation. For both formulations, emphasis is laid on the quantitative representation of the nuclear forces. Density-dependent effective nuclear forces are used. Numerical results are given only for the second formulation. The surface thickness of the mass density is found to be 2.5 fm, but when the finite size of the proton is folded in, a thickness of 3.3 fm is obtained for the charge density, compared to a measured value of 2.4 fm. Various suggestions are made for reducing the calculated thickness. Making changes compatible with the present situation of nuclear matter theory, the surface thickness may be reduced to 2.2 fm for the mass density and 3.0 fm for the charge density. The electron scattering from the theoretical charge density is calculated and compared with experiment in the distorted-wave approximation method by Yennie, Boos and Ravenhall. The agreement is reasonably good. The theoretical surface energy coefficient is 22–23 MeV for a semi-infinite nucleus, but is reduced to about 18 MeV by a simple-minded correction for curvature, compared to the semi-empirical value 18 MeV. A calculation for the mixed density and the Thomas–Fermi expression for the kinetic energy in a Woods–Saxon type potential is given. A calculation for the S-wave projection of the two-particle state in the linear potential is included. (Diss. Abstr. Int., B)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 46333, 46399, 47723, 47724, and 47918.

47688 (NEIC-RR-39) PRESSURIZED WATER POWER REACTORS. Bibliography, 1957–1968. Kowalski, A. (comp.) (Nuclear Energy Information Center, Warsaw (Poland)). 1970. 283p. Dep. CFSTI (U. S. Sales Only).

Included are 3053 references on pressurized water power reactors. The references were obtained from Nuclear Science Abstracts for the period 1957 to 1968. Corporate author, report number, patent, subject, and reactor indexes are included. (H.D.R.)

47689 (ZJE-79) SYSTEM OF CONTROL OF A-1 NUCLEAR REACTOR WITH MOVING CHAMBERS (MC SYSTEM). Drab, F.; Haniger, L.; Teska, J. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 14p. Dep. CFSTI (U. S. Sales Only).

The theoretical principle of the moving chamber control system developed in Czechoslovakia is discussed. The individual parts and functions are described. (7 references) (auth)

47690 A DECADE OF MATURATION FOR NUCLEAR ENERGY IN THE UNITED STATES LIES AHEAD. Seaborg, Glenn T. (Atomic Energy Commission, Washington, D. C.). Com. Naz. Energ. Nucl., Notiz.; 16: 45-52(Jun 1970). (In Italian).

The prospects of nuclear energy in the next ten years are discussed. The main use of nuclear energy will be for power generation. The great possibilities of controlled nuclear fusion are analyzed. The many uses of radioisotopes and the new possibilities in basic physics are reviewed. (auth)

47691 NUCLEAR POWER IN THE SEVENTIES. Petrosyants, Andronik M. Com. Naz. Energ. Nucl., Notiz.; 16: 53-62 (Jun 1970). (In Italian).

The prospects of development of nuclear power in the next decade are reviewed. Particular emphasis is laid on Soviet activities in the areas of nuclear power plants, on the experiments carried out with the 70-BeV Serpukov protonsynchrotron, and on the present status and prospects of controlled nuclear fusion. (auth)

47692 DIGITAL COMPUTER APPLICATION TO ADVANCED GAS-COOLED REACTOR SYSTEMS. Makin, J. E. (Nuclear Power Group Ltd., Knutsford, Eng.); Shirra, J. M. Neue Tech., B; 12: 17-24(1970).

The English Electric type M2140 processor system applied to the advanced gas-cooled reactor power station at Hinkley Point B is described. (auth)

47693 CONSTRUCTION WORKS IN THE FUKUSHIMA ATOMIC POWER STATION. Fuseya, Kiyoshi (Tokyo Electric Power Co., Inc.). Kensetsu No Kikaika; No. 239, 3-8(Jan 1970). (In Japanese).

Construction of the Fukushima atomic power station was started in the autumn of 1966. No. 1 plant was completed about 90%, waiting for the fuel charge in May 1970. No. 2 plant, of which construction started in January 1969, was completed about 45%. Construction of No. 3 plant will be started in January 1970. The atomic power station is situated on the coast of the Pacific, and the buildings, reactor plants, substations, etc. are set directly on natural rock bed or artificial foundations. Cooling water for the plant steam condensers is taken from the Pacific, and a port capable of accommodating 3,000-ton ships is also provided. The following are described: the site of the power station; leveling of the site; building of the port; production of the aggregate for construction works; building construction, etc.; and plant structures. (Japan)

47694 VANDELLOS NUCLEAR POWER STATION. Buttin, Jean (Societe pour l'Industrie Atomique, Paris). Energ. Nucl. (Paris); 12: 23-32(Jan-Feb 1970). (In French).

The Spanish 500 MW(e) Vandellos power plant is built by a French manufacturer group and different Spanish companies for the account of the Hifrensa company. The main reactor components are identical with components of the Saint-Laurent-2 gas-graphite reactors of the integrated type (gas temperature: 400°C, pressure in core center: 28.5 bars). The circulating water system is ensured by sea-water. The civil engineering works started in July 1967; the assembling of electro-mechanical materials started at the end of 1969. Power rising will take place in the beginning of 1972. (auth) (France)

47695 JAPAN'S NUCLEAR INDUSTRY. Power Eng.; 74: No. 8, 34-9(Aug 1970).

The development of the nuclear power industry in Japan is reviewed. Programs for developing fuel processing plants and for constructing and operating nuclear power plants are described. (D.C.C.)

47696 EXPERIENCE IN THE CONSTRUCTION OF THE BEZNAU ATOMIC POWER PLANT. Veya, R. (Nordostschweizerische Kraftwerke AG, Baden, Switzerland). Neue Tech., B; 11: 278-85(1969). (In German).

The functional principle and lay-out of the double containment of the Beznau nuclear power plant is described. The positive aspects and the particularities of the lifting-jack construction method for the steel container are discussed and experiences in applying the ASME-Codes and in performing the pressure and leak rate tests are communicated. (auth)

47697 PHYSICS PERFORMANCE OF SHIPPINGPORT. Flanagan, C. A. (Westinghouse Electric Corp., West Mifflin, Pa.). Nucl. Appl. Technol.; 9: 640-50(Nov 1970).

The physics performance of Shippingport Core 2 operations from initial startup of the first seed through initial power operations on the second seed is summarized. The emphasis is on comparison of observed results with calculated results to identify the ability of current calculational techniques to describe core operations. Also included are selected comparisons of results of isotopic examination programs performed on Core 1 seed and blanket fuel assemblies. The comparisons indicate that critical core configurations are described with varying degrees of success with reactivity deviations generally less than 1% $\Delta\rho$. Power distributions agree reasonably well with measured values. Results of destructive analysis programs indicate that both gross and local fuel depletion are calculated to within 5–10%. 14 references. (auth)

47698 CONSTRUCTION OF THE TSURUGA ATOMIC POWER STATION. Onishi, Sotoaki (Japan Atomic Power Co., Tokyo). Kensetsu No Kikaika; No. 239, 9-13(Jan 1970). (In Japanese).

Construction of the Tsuruga atomic power station of Japan Atomic Power Company was started in April 1966. In September 1969, fuel was charged into the reactor and after various tests, it will go into practical operation. The site, leveled for the construction of the station, is surrounded by hills on three sides, and the west side faces the Japan Sea. The power station employs a BWR, and cooling water for condensers is taken from the sea. The following are described: buildings and structures, including the reactor containment building and dry-well, suppression chamber, etc., service building, waste-treatment building and turbine building; an exhaust stack and associated tunnels etc.; and condenser cooling sea-water intake facilities. (Japan)

47699 300-MW MUEHLEBERG ATOMIC POWER PLANT OF THE BERN POWER SYSTEM AG: GENERAL DESCRIPTION OF THE INSTALLATION. Caprez, R. (Brown Boveri and Cie, Baden, Switzerland); Kallas, E. Neue Tech., B; 12: 39-60(1970). (In German).

On September 1, 1966 the Suppliers Consortium Brown Boveri/General Electric received from the Bernische Kraftwerke an order for the supply of a turnkey nuclear power plant of 306 MW net output. The start of construction was set for April 1, 1967. The plant will be delivered to the customer ready for operation on October 1, 1971. General Electric supplies the nuclear boiler with its auxiliary systems, the primary containment, the equipment for the treatment of liquid radioactive wastes, and the nuclear fuel. Brown Boveri supplies the turbosets, the auxiliary systems, the civil construction work, and performs the overall planning. Brown Boveri is the managing partner in the Suppliers Consortium. The plant arrangement, especially the selection of two turbosets of 50% reactor capacity each corresponds to the layout criteria of the customer. The double pressure suppression systems fulfill the requirements set by the authorities for the safeguard of nuclear plants. (auth)

47700 NUCLEAR POWER PANORAMA: COMPREHENSIVE DISPLAY BY BRITAIN AT BASEL NUCLEX 69. Rippon, S. E. Neue Tech., B; 11: 185-91(1969).

47701 CANADA'S NUCLEAR POWER PROGRAM. Law, Charles W. (ed.). (Canadian Nuclear Association, Toronto). Neue Tech., B; 11: 193-6(1969).

The status and probable course of development of the Canadian heavy water reactor program are discussed. The CANDU type

power plants, natural uranium fuel cycle development, heavy water production, and fuel reprocessing prospects are examined. (H.D.R.)

47702 SWEDISH NUCLEAR ENERGY ACTIVITIES. Sandstroem, S. (Aktiebolaget Atomenergi, Stockholm). Neue Tech., B; 11: 199-203(1969).

The nuclear power development program in Sweden is reviewed. The status of operating and planned nuclear power plants is described. (H.D.R.)

47703 BELGIAN NUCLEAR INDUSTRY. Neue Tech., B; 11: 205-16(1969).

The nuclear power development activities in Belgium are examined. The Nuclear Energy Research Centre programs, fuel cycle developments, the Doel and Tihange power plants, the HTR concept development, and nuclear industry equipment manufacture are discussed. (H.D.R.)

47704 ASEA-ATOM BOILING WATER REACTOR. Tenerz, E.; Widell, B. (AB ASEA-ATOM, Vaesteras, Sweden). Neue Tech., B; 11: 292-6(1969).

A presentation of AB ASEA-ATOM's BWR is given with special reference to the background of the design philosophy. The theoretical and experimental results from the last five years' development work are discussed from the point of view of fuel and core lay-out. The development has been extensive and the present design is more advanced than that for the first reactor. This can be seen from the increased power density and burn-up as well as the reduced thicknesses of cladding and boxes. (auth)

47705 SURVEY OF SWEDEN. Aler, Bo (Aktiebolaget Atomenergi, Stockholm); Margen, P.; Holmin, Nils; Sandstroem, Sten; Brandberg, Sven; Hultkrantz, B. O. Nucl. Eng. Int.; 15: 697-713(Sep 1970).

The commercial break-through for nuclear power and the Government's nuclear development program are discussed. An outline is given of the energy situation in Sweden and of the role of nuclear power. A summary of the nuclear industry includes a chart showing the relation between government and commercial organizations. There are descriptions of the research and development programs at Studsvik, of fuel fabrication, and of new facilities for fabrication of heavy nuclear pressure vessels. The organization of commercial enterprises for the building of Oskarshamn and Barsebaeck power stations is briefly outlined. (UK)

Operation and Economics

Refer also to abstract 47919.

47706 (AECL-3569) CANADIAN OPERATING EXPERIENCE WITH HEAVY WATER POWER REACTORS. Lewis, W. Bennett; Foster, John S. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). Aug 1970. 48p. (DL-101). Dep. CFSTI (U. S. Sales Only). AECL $1.50.

Fourteen Canadian designed heavy-water power reactors are listed with a total generating capacity of six million kilowatts. These are envisaged as starting an economically viable line into the indefinite future based on their demonstrated low fuelling costs, which can be lowered even further by selling the spent fuel for use by other economic reactors that require plutonium or uranium-233. New operating experience from the first 200 MW(e) reactor at Douglas Point is presented as well as updated results from eight years of operation of the 22 MW(e) demonstration station, NPD. Successful on-power fuelling has been demonstrated by over 1300 operations at NPD, and for over five months at Douglas Point. Promising improvements continue in the reduction of heavy water losses, with new techniques for detecting and recovering heavy water from leaks. Problems of transport of radioactive corrosion products are discussed, also experience with mechanical equipment, especially pumps, valves and the turbine. Development and recent cost experience are briefly reviewed. (auth)

47707 (DOCKET-1155-72) LA CROSSE BOILING WATER REACTOR. Monthly Operating Report, June 1970. (Dairyland Power Cooperative, La Crosse, Wis.). 17 Sep 1970. Contract AT(11-1)-851. 28p. (DPC-851-12). Dep. CFSTI.

47708 (DOCKET-1155-73) LA CROSSE BOILING WATER REACTOR. Unplanned Reactor Scram. Incident Report No. DPC-70-14. (Dairyland Power Cooperative, La Crosse, Wis.). 17 Sep 1970. 2p. Dep. CFSTI.

47709 (DOCKET-1155-74) LA CROSSE BOILING WATER REACTOR. Unplanned Reactor Scram. Incident Report No. DPC-70-15. (Dairyland Power Cooperative, La Crosse, Wis.). 18 Sep 1970. 2p. Dep. CFSTI.

47710 (DOCKET-1155-75) LA CROSSE BOILING WATER REACTOR. Failure of Control Rod No. 13 to Scram Hydraulically. Incident Report No. DPC-70-16. (Dairyland Power Cooperative, La Crosse, Wis.). 16 Sep 1970. 3p. Dep. CFSTI.

47711 (DOCKET-1155-76) LA CROSSE BOILING WATER REACTOR. Failure of Control Rod No. 13 to Withdraw on Reactor Startup. Incident Report No. DPC-70-17. (Dairyland Power Cooperative, La Crosse, Wis.). 16 Sep 1970. 2p. Dep. CFSTI.

47712 (DOCKET-50016-79) ENRICO FERMI ATOMIC POWER PLANT. [Operations] Report, June 1970. (Power Reactor Development Co., Detroit, Mich.). 14 Sep 1970. 14p. (PRDC-EF-82). Dep. CFSTI.

47713 (DOCKET-50016-80) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Incident Involving Sodium-Water Reactions. (Power Reactor Development Co., Detroit, Mich.). 21 May 1970. 2p. Dep. CFSTI.

47714 (DOCKET-50171-55) PEACH BOTTOM ATOMIC POWER STATION, UNIT 1. Monthly Operations Report No. 53, July 1970. (Philadelphia Electric Co., Pa.). 17 Sep 1970. 18p. Dep. CFSTI.

47715 (DOCKET-50206-89) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Operation Report, August 1970. (Southern California Edison Co., Los Angeles). Sep 1970. Contract AT(30-1)-3270. 5p. (NYO-3270-41). Dep. CFSTI.

47716 (DOCKET-50213-73) CONNECTICUT YANKEE ATOMIC POWER PLANT. Oil Leakage Resulting in Intermittent Localized Flashing of Oil Contaminated Thermal Insulation. (Connecticut Yankee Atomic Power Co., Westboro, Mass.). 16 Sep 1970. 7p. Dep. CFSTI.

47717 (DOCKET-50213-75) CONNECTICUT YANKEE ATOMIC POWER PLANT. Operation Report No. 70-8, August 1970. (Connecticut Yankee Atomic Power Co., Haddam). 18 Sep 1970. Contract AT(30-1)-3250. 13p. (NYO-3250-51). Dep. CFSTI.

47718 (DOCKET-50219-105) OYSTER CREEK NUCLEAR GENERATING STATION, UNIT NO. 1. Semiannual Report No. 1, Supplement No. 1 to Appendix C and Addition to Report of Operations. (Jersey Central Power and Light Co., Morristown, N. J.). 14 Sep 1970. 5p. Dep. CFSTI.

Maintenance requirements for the control rod drives during October 1969 are described. (D.C.C.)

47719 (DOCKET-50263-45) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Failures of System Components in the Standby Gas Treatment System. (Northern States Power Co., Minneapolis, Minn.). 18 Sep 1970. 10p. Dep. CFSTI.

47720 CONSIDERATIONS ON FIFTEEN YEARS' EXPERIENCE IN THE FIELD OF NUCLEAR PLANT. Angelini, A. M. (Ente Nazionale per l'Energia Elettrica, Rome). Neue Tech., B; 11: 267-73(1969).

The main technical results of the experience acquired from operation of the three Italian nuclear power stations are discussed, with special reference to plant safety, reliability and economics in relation to service continuity and reserve capacity requirements. A few considerations are made on the applicability of this experience to a new nuclear power projects. A brief review is made of the problems facing a station operator as a result of the numerous reactor concepts still in competition. (auth)

47721 EXPERIENCE WITH THE GERMAN NUCLEAR POWER PLANTS, GUNDREMMINGEN, OBRIGHEIM, AND LINGEN IN 1968. Weckesser, A. (RWE-Bayernwerk GmbH, Gundremmingen, Ger.). Neue Tech., B; 11: 274-8(1969). (In German).

In 1968 the Federal Republic of Germany had three nuclear plants with capacities of more than 200 MW(e). During startup, difficulties occurred at all plants and caused delays or shutdowns. In Gundremmingen difficulties occurred with the turbine, in Lingen with the control rod drives, and in Obrigheim with the thermal shield and the steam dryers. In the meantime the difficulties have been removed almost entirely. (auth)

47722 NEUTRON FLUX SCANNER FOR THE STARTUP TESTS OF THE LUCENS REACTOR. Behringer, K.; Dubochet, E. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Neue Tech., B; 11: 61-8(1969). (In German).

Thick flexible copper wires were used for the measurement of thermal neutron flux distributions in the Lucens reactor during the start-up period. An instrument was developed to scan automatically the activity distribution induced along a wire. The wire is

guided in discrete steps through a symmetrical double collimator. Two NaI(Tl) scintillators count in coincidence the annihilation γ quanta from the positron emission of ^{64}Cu. The data are punched on paper tape which can be fed directly to a computer for further processing. (auth)

47723 PHYSICS OF OPERATING PRESSURIZED WATER REACTORS. McFarlane, A. F. (Westinghouse Electric Corp., Pittsburgh). Nucl. Appl. Technol.; 9: 634-9(Nov 1970).

Some important design features which improve reactor core performance are currently being evaluated. The design predictions of reactivity effects associated with the use of Zircaloy clad fuel, burnable poisons and part length control rods show good agreement with measurements made in recently commissioned reactors. Power distribution measurements are also compared with calculated values. A discussion of power distribution control and its relation to core performance is given. This discussion highlights the importance of whole-core calculations with analytical models whose accuracy has been experimentally verified. (auth)

47724 PHYSICS OF OPERATING BOILING WATER REACTORS. Fuller, E. D. (General Electric Co., San Jose, Calif.). Nucl. Appl. Technol.; 9: 622-33(Nov 1970).

With the increasing volume of operating boiling water reactors, it becomes increasingly important to be able to apply a single predictive analysis computer program to all plants. In addition, it behooves the responsible nuclear designer to take advantage of the existing operating experience in checking out predictive methods before they are applied to an operating system. General Electric has developed an improved boiling water reactor computer program for predicting three dimensional core performance that will be applied to all operating reactors. A review of the type of performance achieved in operating boiling water reactors and the current ability to predict this performance is presented. (auth)

47725 PLUTONIUM RECYCLE STUDIES FOR THE SENA PWR REACTOR. Debrue, J.; Deramaix, P.; de Waegh, F. (Belgonucleaire, Brussels). Nucl. Appl. Technol.; 9: 516-27 (Oct 1970).

Based on the experience gained by the fuel fabrication and development work completed so far, a specific study of plutonium recycle has been undertaken with the SENA reactor characteristics taken as a reference. The headlines of this study are presented. A brief description of the SENA reactor is given, followed by the ground rules adopted in the selection of plutonium recycle schemes. The methods of physics calculations are shortly described. The main results of the calculations performed for successive plutonium enriched reloads are given, as well as their comparison with experimental values measured on mockups of the SENA fuel assemblies. Finally, an economic evaluation points out the respective merits of the two considered basic recycle schemes where the plutonium is mixed respectively with natural uranium and with slightly enriched uranium arising from the reprocessing of the SENA fuel. (auth)

Safety and Siting

47726 (BNWL-1405) POTENTIAL THERMAL EFFECTS OF AN EXPANDING POWER INDUSTRY: UPPER MISSISSIPPI RIVER BASIN. Peterson, D. E.; Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 95p. Dep. CFSTI.

Direct cooling capacities of the main stem Mississippi River and eight major tributaries between Royalton, Minnesota and Alton, Illinois for average and low flow conditions were simulated within a temperature constraint of 5°F above natural background. Total assimilative and dissipative capacity of the upper Mississippi Basin ranged from a high of 130 GW_T to a low of 46 GW_T. Analyses of projected power growth patterns indicate that the main stem has adequate cooling capacity to accommodate forecasted loads through the year 1990, except in the St. Paul–Minneapolis area. Partial recirculatory cooling facilities appear to be a possible solution to tributary basin cooling water requirements beyond the year 1980. (auth)

47727 (CONF-700810-5) THE CONTROL OF RIVER HEATING BY ACCURATE DIGITAL SIMULATION. COMPARISON BETWEEN COMPUTATION AND NATURE. Boegh, P.; Zuend, H. (Motor-Columbus Consulting Engineers, Inc., Baden (Switzerland)). [1970]. 11p. (SM-146/45). Dep. CFSTI (U. S. Sales Only).

From Symposium on Environmental Aspects of Nuclear Power Stations, New York, N. Y.

A computer program was developed with a large flexibility allowing for tributaries with variable temperatures, several different time-varying meteorological conditions along a river, heat sources with time-variable intensity, variable river geometry, simulation of the dispersion (longitudinal mixing) by having two (easily changeable to more) channels with different water velocities, etc. The time interval in the simulation can be made rather short (down to half an hour) allowing to follow closely the important daily temperature variations. All the above characteristics of the program are necessary to simulate satisfactorily the fast-flowing rivers of Switzerland. The program is described and computations commented on. Sample results are compared with the measured natural temperatures and it is shown how the daily temperature variations (due to day-time heating and night-time cooling) are valuable for adjusting the heat transfer coefficients, up to now primarily measured in lakes, for the simulation of rivers. (auth)

47728 (DOCKET-1155-71) LA CROSSE BOILING WATER REACTOR. Unplanned Reactor Scram. (Dairyland Power Cooperative, La Crosse, Wis.). 8 Sep 1970. 3p. (DPC-70-13). Dep. CFSTI.

47729 (DOCKET-50003-50) INDIAN POINT STATION, UNIT NO. 1. Technical Specifications, App. A. (Consolidated Edison Co. of New York, Inc., New York). 14 Sep 1970. 23p. Dep. CFSTI.

Technical specifications concerning the power capability analysis for 3-loop operation are presented. (D.C.C.)

47730 (DOCKET-50016-78) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Malfunction of Two Monitoring Instruments. (Power Reactor Development Co., Detroit, Mich.). 14 Sep 1970. 2p. Dep. CFSTI.

47731 (DOCKET-50016-81) ENRICO FERMI ATOMIC POWER PLANT, UNIT 1. Detailed Information Regarding Stainless Steel Sensitization. (Power Reactor Development Co., Detroit, Mich.). 15 Sep 1970. 45p. Dep. CFSTI.

47732 (DOCKET-50029-128) YANKEE NUCLEAR POWER STATION. License No. DPR-3; Technical Specifications Proposed Change No. 92, Suppl. 1. (Yankee Atomic Electric Co., Westboro, Mass.). 15 Sep 1970. 2p. Dep. CFSTI.

Inspection schedule for the reactor vessel studs is described. (D.C.C.)

47733 (DOCKET-50206-90) SAN ONOFRE NUCLEAR GENERATING STATION, UNIT 1. Information on Sensitized Stainless Steel Materials. (Southern California Edison Co., Los Angeles). 9 Sep 1970. 9p. Dep. CFSTI.

47734 (DOCKET-50213-74) CONNECTICUT YANKEE ATOMIC POWER PLANT. License No. DPR-14. Technical Specifications, Proposed Change No. 16 to Appendix A. (Connecticut Yankee Atomic Power Co., Hartford). 21 Sep 1970. 32p. Dep. CFSTI.

Revised technical specifications concerning personnel responsibilities are presented. Personnel qualifications are listed. (D.C.C.)

47735 (DOCKET-50219-103) OYSTER CREEK NUCLEAR GENERATING STATION, UNIT NO. 1. Secondary Containment Leak Rate Testing. Summary Technical Report, July 1969–June 1970. (Jersey Central Power and Light Co., Morristown, N. J.). 14 Sep 1970. 12p. Dep. CFSTI.

47736 (DOCKET-50219-104) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Technical Specifications Change Request No. 3. (Jersey Central Power and Light Co., Morristown, N. J.). 10 Sep 1970. 3p. Dep. CFSTI.

Modification of protective instrumentation requirements is described. Procedures for testing a channel in a trip system are presented. (D.C.C.)

47737 (DOCKET-50219-106) OYSTER CREEK NUCLEAR POWER PLANT, UNIT NO. 1. Preliminary Safety Analysis Report, Amendment 63. (Jersey Central Power and Light Co., Morristown, N. J.). 17 Sep 1970. 7p. Dep. CFSTI.

Revised and addition information concerning 1690 MW(t) operation is presented. (D.C.C.)

47738 (DOCKET-50237-70) DRESDEN NUCLEAR POWER STATION, UNIT 2. Correction in High Pressure Coolant Injection System. (Commonwealth Edison Co., Chicago, Ill.). 10 Sep 1970. 2p. Dep. CFSTI.

47739 (DOCKET-50237-71) DRESDEN NUCLEAR POWER STATION, UNIT 2. Proposed Change No. 6 to Appendix A of

DPR-19. (Commonwealth Edison Co., Chicago, Ill.). 14 Sep 1970. 7p. Dep. CFSTI.

Inspection of furnace sensitized stainless steel core spray nozzle safe ends and their welds is described. Calibration and inspection requirements for temperature and pressure monitors are presented. The temperature limitation for the main steam-line air pilot valves is discussed. (D.C.C.)

47740 (DOCKET-50237-72) DRESDEN NUCLEAR POWER STATION, UNIT 2. Exhibit 1, Additional Information Requested July 24, 1970. (Commonwealth Edison Co., Chicago, Ill.). 17 Sep 1970. 7p. Dep. CFSTI.

Additional information is presented on furnace-sensitized stainless steel core spray nozzle safe ends. (D.C.C.)

47741 (DOCKET-50237-73) DRESDEN NUCLEAR POWER STATION, UNIT 2. Relief Valve Capacities Less Than Ten Percent Under Design Capacity. (General Electric Co., San Jose, Calif. Nuclear Energy Div.). 18 Sep 1970. 1p. Dep. CFSTI.

47742 (DOCKET-50237-74) DRESDEN NUCLEAR POWER STATION, UNIT 2. Technical Specifications, Safety Evaluation of Change No. 3. (Division of Reactor Licensing (AEC), Washington, D. C.). 18 Sep 1970. 3p. Dep. CFSTI.

Safety evaluation of the proposed setpoint for the high flow isolation trip of the isolation condenser condensate return line is presented. (D.C.C.)

47743 (DOCKET-50254-20) QUAD-CITIES STATION, UNITS 1 AND 2. License Application, Amendment 12. (Commonwealth Edison Co., Chicago, Ill. Iowa-Illinois Gas and Electric Co., Davenport, Iowa). 3 Sep 1970. 6p. (DOCKET-50265-17). Dep. CFSTI.

Additional information concerning physics parameters of the initial core loading using Gd_2O_3 as a burnable poison is presented. (D.C.C.)

47744 (DOCKET-50263-43) MONTICELLO NUCLEAR GENERATING PLANT, UNIT 1. Site Assembly of the Pressure Vessel. (Division of Reactor Licensing (AEC), Washington, D. C.). 13 Sep 1966. 27p. Dep. CFSTI.

47745 (DOCKET-50267-20) FORT ST. VRAIN NUCLEAR GENERATING STATION. License Application, Amendment 1. (Public Service Co. of Colorado, Denver). 19 Apr 1967. 214p. Dep. CFSTI.

47746 (DOCKET-50267-21) FORT ST. VRAIN NUCLEAR GENERATING STATION. License Application, Amendment 4. (Public Service Co. of Colorado, Denver). 29 Aug 1967. 343p. Dep. CFSTI.

47747 (DOCKET-50267-22) FORT ST. VRAIN NUCLEAR GENERATING STATION. Informational Report, No. 1. (Public Service Co. of Colorado, Denver). 14 Apr 1969. 208p. Dep. CFSTI.

47748 (DOCKET-50269-24) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. Preliminary Safety Analysis Report, Amendment 21 (Includes Final Safety Analysis Report, Rev. 13). (Duke Power Co., Charlotte, N. C.). 17 Sep 1970. 29p. (DOCKET-50270-24; DOCKET-50287-21). Dep. CFSTI.

A multi-node computer program analysis of coolant loss accident conditions is presented. (D.C.C.)

47749 (DOCKET-50269-25) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. License Application, Amendment 6. (Duke Power Co., Charlotte, N. C.). 26 Mar 1969. 49p. (DOCKET-50270-25; DOCKET-50287-22). Dep. CFSTI.

47750 (DOCKET-50269-26) OCONEE NUCLEAR STATION, UNITS 1, 2, AND 3. License Application, Amendment 20 (Includes Final Safety Analysis Report, Rev. 12). (Duke Power Co., Charlotte, N. C.). 14 Sep 1970. 27p. (DOCKET-50270-26; DOCKET-50287-23). Dep. CFSTI.

47751 (DOCKET-50271-30) VERMONT YANKEE NUCLEAR POWER STATION. License Application. (Vermont Yankee Nuclear Power Corp., Rutland). 30 Nov 1966. 11p. Dep. CFSTI.

47752 (DOCKET-50271-31) VERMONT YANKEE NUCLEAR POWER STATION. License Application, Amendment 8. (Vermont Yankee Nuclear Power Corp., Rutland). 16 Jun 1967. 292p. Dep. CFSTI.

Financial data on the owners of the Vermont Yankee Power Reactor are given in support of the application for construction permit and operating license. The 1966 Annual Reports for the Central Vermont Public Service Corporation, Green Mountain Power Corporation, New England Power Company, the Connecticut Light and Power Company, Central Maine Power Company, Public Service Company of New Hampshire, the Hartford Electric Light Company, and Eastern Utilities Associates are included. (D.C.C.)

47753 (DOCKET-50271-32) VERMONT YANKEE NUCLEAR POWER STATION. License Application, Amendment 9. (Vermont Yankee Nuclear Power Corp., Rutland). 31 Oct 1968. 244p. Dep. CFSTI.

Financial data on the owners of the Vermont Yankee Power Reactor are given in support of the application for construction permit and operating license. The 1967 Annual Reports of the Central Vermont Public Service Corporation, Green Mountain Power Corporation, New England Power Company, the Connecticut Light and Power Company, the Central Maine Power Company, Public Service Company of New Hampshire, the Hartford Electric Light Company, Cambridge Electric Light Company, and Eastern Utilities Associates are included. (D.C.C.)

47754 (DOCKET-50272-9) SALEM NUCLEAR GENERATING STATION, NO. 1 AND 2. License Application, Amendment 9. (Public Service Electric and Gas Co., Newark, N. J.). 21 May 1968. 63p. (DOCKET-50311-9). Dep. CFSTI.

47755 (DOCKET-50272-10) SALEM NUCLEAR GENERATING STATION, NO. 1 AND 2. License Application, Part A (Amendment 7). (Public Service Electric and Gas Co., Newark, N. J.). Apr 1968. 144p. (DOCKET-50311-10). Dep. CFSTI.

Financial data on the owners of the Salem Power Reactor Units 1 and 2 are given in support of the application for construction permit and operating license. The 1967 Annual Reports for the Public Service Electric and Gas Company, Delmarva Power and Light Company, Philadelphia Electric Company, and the Atlantic City Electric Company are included. (D.C.C.)

47756 (DOCKET-50275-11) DIABLO CANYON NUCLEAR POWER PLANT, UNIT 1. License Application. (Pacific Gas and Electric Co., San Francisco, Calif.). Jan 1967. 40p. Dep. CFSTI.

Financial data on the owners of the Diablo Canyon Power Reactor Unit 1 are given in support of the application for construction permit and operating license. The 1965 Annual Report for the Pacific Gas and Electric Company is included. (D.C.C.)

47757 (DOCKET-50275-12) DIABLO CANYON NUCLEAR POWER PLANT, UNIT 1. License Application, Amendment 8. (Pacific Gas and Electric Co., San Francisco, Calif.). 30 Nov 1967. 8p. Dep. CFSTI.

Design requirements for a tsunami are presented. Revised and additional information on reactor control and instrumentation is presented. (D.C.C.)

47758 (DOCKET-50275-13) DIABLO CANYON NUCLEAR POWER PLANT, UNIT 1. License Application, Amendment 9. (Pacific Gas and Electric Co., San Francisco, Calif.). 6 Dec 1967. 12p. Dep. CFSTI.

Stress design limits for Class 1 components and equipment are analyzed. Stress analysis of reactor vessel outlet nozzle is presented. (D.C.C.)

47759 (DOCKET-50277-18) PEACH BOTTOM ATOMIC POWER STATION, UNITS 2 AND 3. License Application, Amendment 4. (Philadelphia Electric Co., Pa.). 6 Oct 1967. 5p. (DOCKET-50278-18). Dep. CFSTI.

Additional information is presented concerning cooling tower operation, emergency core cooling system, flood hazards, and thermal shocks from coolant loss conditions. (D.C.C.)

47760 (DOCKET-50282-22) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. License Application, Amendment 6. (Division of Compliance (AEC), Washington, D. C.). 6 Mar 1968. 27p. (DOCKET-50306-22). Dep. CFSTI.

47761 (DOCKET-50282-23) PRAIRIE ISLAND NUCLEAR GENERATING PLANT, UNITS 1 AND 2. Comments on Remarks of Inspectors Relative to Manufacture of Reactor Pressure Vessels. (Northern States Power Co., Minneapolis, Minn.). 10 Sep 1970. 7p. (DOCKET-50306-23). Dep. CFSTI.

47762 (DOCKET-50285-28) FORT CALHOUN STATION, UNIT 1. License Application, Amendment 9 (Includes Facility Description and Safety Analysis Report, Suppl. No. 9). (Omaha Public Power District, Nebr.). 13 Nov 1967. 7p. Dep. CFSTI.

Additional geologic data for the reactor site and surrounding area are presented. (D.C.C.)

47763 (DOCKET-50285-29) FORT CALHOUN STATION, UNIT 1. License Application, Amendment 10 (Includes Facility Description and Safety Analysis Report, Suppl. No. 10). (Omaha Public Power District, Nebr.). 13 Nov 1967. 26p. Dep. CFSTI.

47764 (DOCKET-50285-30) FORT CALHOUN REACTOR. Pre-Operational Environmental Survey. Seventh Report, 2nd Quarter 1970. (Trapelo/West, Richmond, Calif.). 28 Aug 1970. 18p. Dep. CFSTI.

47765 (DOCKET-50285-31) FORT CALHOUN STATION, UNIT 1. License Application. (Omaha Public Power District, Nebr.). Apr 1967. 64p. Dep. CFSTI.

47766 (DOCKET-50285-32) FORT CALHOUN STATION, UNIT 1. Final Safety Analysis Report, Vol. 1. (Omaha Public Power District, Nebr.). 28 Nov 1969. 274p. Dep. CFSTI.

Information on Fort Calhoun Power Reactor Unit 1 is presented under the following broad topics: Introduction and Summary; Site and Environs; and Reactor. (D.C.C.)

47767 (DOCKET-50285-33) FORT CALHOUN STATION, UNIT 1. Final Safety Analysis Report, Vol. 2. (Omaha Public Power District, Nebr.). 28 Nov 1969. 337p. Dep. CFSTI.

Information on Fort Calhoun Power Reactor Unit 1 is presented under the following broad topics: Reactor Coolant System; Structures; Engineered Safeguards Systems; and Instrumentation and Control. (D.C.C.)

47768 (DOCKET-50285-34) FORT CALHOUN STATION, UNIT 1. Final Safety Analysis Report, Vol. 3. (Omaha Public Power District, Nebr.). 28 Nov 1969. 254p. Dep. CFSTI.

Information on Fort Calhoun Power Reactor Unit 1 is presented under the following broad topics: Electrical Systems; Auxiliary Systems; Steam and Power Conversion Systems; Radioactive Waste and Radiation Protection and Monitoring; and Conduct of Operations. (D.C.C.)

47769 (DOCKET-50285-35) FORT CALHOUN STATION, UNIT 1. Final Safety Analysis Report, Vol. 4. (Omaha Public Power District, Nebr.). 28 Nov 1969. 205p. Dep. CFSTI.

Safety analysis of possible operation incidents is presented. (D.C.C.)

47770 (DOCKET-50285-36) FORT CALHOUN STATION, UNIT 1. Final Safety Analysis Report, Vol. 5. (Omaha Public Power District, Nebr.). 28 Nov 1969. 275p. Dep. CFSTI.

Information on Fort Calhoun Power Reactor Unit 1 is presented under the following topics: quality assurance program; site environmental studies; foundation studies; pipe load test programs; qualifications of personnel; and classification of structures and equipment and seismic criteria. (D.C.C.)

47771 (DOCKET-50286-28) INDIAN POINT NUCLEAR GENERATING UNIT NO. 3. Application for Licenses. (Consolidated Edison Co. of New York, Inc., New York). Apr 1967. 51p. Dep. CFSTI.

Financial data on the owners of the Indian Point Power Reactor Unit 3 are given in support of the application for construction permit and operating license. The 1966 Annual Report for the Consolidated Edison Company is included. (D.C.C.)

47772 (DOCKET-50293-27) PILGRIM NUCLEAR POWER STATION. Design and Analysis Report, Amendment 6, Supplement to Amendment 5. (Boston Edison Co., Mass.). 11 Mar 1968. 51p. Dep. CFSTI.

47773 (DOCKET-50295-11) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 5. (Commonwealth Edison Co., Chicago, Ill.). 1 Mar 1968. 143p. (DOCKET-50304-11). Dep. CFSTI.

47774 (DOCKET-50295-12) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 8. (Commonwealth Edison Co., Chicago, Ill.). 3 May 1968. 57p. (DOCKET-50304-12). Dep. CFSTI.

47775 (DOCKET-50295-13) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 9. (Commonwealth Edison Co., Chicago, Ill.). 6 Jun 1968. 3p. (DOCKET-50304-13). Dep. CFSTI.

Additional information concerning engineered safeguards for coolant loss accident conditions is presented. (D.C.C.)

47776 (DOCKET-50295-14) ZION STATION, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 10. (Commonwealth Edison Co., Chicago, Ill.). 27 Jun 1968. 5p. (DOCKET-50304-14). Dep. CFSTI.

Financial data on the owners of the Zion Power Reactor Units 1 and 2 are given in support of the application for construction permit and operating license. (D.C.C.)

47777 (DOCKET-50298-12) COOPER NUCLEAR STATION. Preliminary Safety Analysis Report, Amendment 1. (Consumers Public Power District, Columbus, Nebr.). 1 Dec 1967. 33p. Dep. CFSTI.

47778 (DOCKET-50301-24) POINT BEACH NUCLEAR PLANT, UNIT NO. 2. Applicant's Environmental Report: Operating License Stage. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Sep 1970. 359p. Dep. CFSTI.

Geologic, hydrologic, and meteorologic data for the reactor site are presented. Information concerning chemical, radioactive, and thermal discharges from the reactor is included. The effects of reactor operations on the environment are analyzed. (D.C.C.)

47779 (DOCKET-50302-15) CRYSTAL RIVER NUCLEAR GENERATING PLANT, UNITS 3 AND 4. Preliminary Safety Analysis Report, Amendment 4. (Florida Power Corp., St. Petersburg). 14 Mar 1968. 37p. (DOCKET-50303-10). Dep. CFSTI.

47780 (DOCKET-50305-9) KEWAUNEE NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 2. (Wisconsin Public Service Corp., Green Bay). 12 Feb 1968. 238p. Dep. CFSTI.

47781 (DOCKET-50305-10) KEWAUNEE NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 3. (Wisconsin Public Service Corp., Green Bay). 15 Mar 1968. 158p. Dep. CFSTI.

47782 (DOCKET-50305-11) KEWAUNEE NUCLEAR POWER PLANT. Preliminary Safety Analysis Report, Amendment 6. (Wisconsin Public Service Corp., Green Bay). 3 May 1968. 159p. Dep. CFSTI.

47783 (DOCKET-50309-22) MAINE YANKEE ATOMIC POWER STATION. Preliminary Safety Analysis Report, Vol. 2. (Maine Yankee Atomic Power Co., Wiscasset). 11 Oct 1967. 321p. Dep. CFSTI.

Information on Maine Yankee Power Reactor is presented under the following broad topics: Instrumentation and Control; Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion; Radiation Protection; Station Operations; Initial Tests and Operation; and Safety Analyses. (D.C.C.)

47784 (DOCKET-50312-17) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 3. (Sacramento Municipal Utility District, Calif.). 30 May 1968. 286p. Dep. CFSTI.

47785 (DOCKET-50312-18) RANCHO SECO NUCLEAR GENERATING STATION, UNIT 1. Preliminary Safety Analysis Report, Amendment 4. (Sacramento Municipal Utility District, Calif.). 30 Jun 1968. 187p. Dep. CFSTI.

47786 (DOCKET-50313-22) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, Suppl. 2. (Arkansas Power and Light Co., Little Rock). 19 Feb 1968. 173p. Dep. CFSTI.

Name changed later to Arkansas Nuclear One.

47787 (DOCKET-50313-23) RUSSELLVILLE NUCLEAR UNIT. Preliminary Safety Analysis Report, Suppl. 8. (Arkansas Power and Light Co., Little Rock). 26 Aug 1968. 12p. Dep. CFSTI.

Name changed later to Arkansas Nuclear One.

Revised and additional information concerning stress limits in the reinforced and prestressed concrete containment structure is presented. (D.C.C.)

47788 (DOCKET-50315-24) DONALD C. COOK NUCLEAR PLANT, UNITS 1 AND 2. Application for Construction Permit and Operating License. (Indiana and Michigan Electric Co., Fort Wayne, Ind.). 18 Dec 1967. 82p. (DOCKET-50316-24). Dep. CFSTI.

Financial data on the owners of the Donald C. Cook Power Reactor Units 1 and 2 are given in support of the application for construction permit and operating license. The 1966 Annual Reports

for the American Electric Power Company and the Indiana and Michigan Electric Company are included. (D.C.C.)

47789 (DOCKET-50319-9) BELL STATION. Application for Licenses. (New York State Electric and Gas Corp., Binghamton). 25 Mar 1968. 44p. Dep. CFSTI.

Financial data on the owners of the Bell Station Power Reactor are given in support of the application for construction permit and operating license. The 1967 Annual Report for the New York State Electric and Gas Corporation is included. (D.C.C.)

47790 (DOCKET-50323-11) DIABLO CANYON NUCLEAR POWER PLANT, UNIT 2. License Application. (Pacific Gas and Electric Co., San Francisco, Calif.). 1 Jul 1968. 42p. Dep. CFSTI.

Financial data on the owners of the Diablo Canyon Power Reactor Unit 2 are given in support of the application for construction permit and operating license. The 1967 Annual Report for the Pacific Gas and Electric Company is included. (D.C.C.)

47791 (DOCKET-50329-21) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 17. (Consumers Power Co., Jackson, Mich.). 11 Sep 1970. 5p. (DOCKET-50330-20). Dep. CFSTI.

Revised design parameters of the tertiary heat exchanger system are presented. (D.C.C.)

47792 (DOCKET-50329-22) MIDLAND PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 18. (Consumers Power Co., Jackson, Mich.). 15 Sep 1970. 3p. (DOCKET-50330-21). Dep. CFSTI.

Radiological hazards due to failure of the tertiary heat exchanger system are analyzed. (D.C.C.)

47793 (DOCKET-50336-19) MILLSTONE NUCLEAR POWER STATION, UNIT 2. Comments Received on Environmental Statement. (Division of Reactor Licensing (AEC), Washington, D. C.). 15 Sep 1970. 130p. Dep. CFSTI.

47794 (DOCKET-50341-18) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Applicant's Environmental Report: Construction Permit Stage. (Detroit Edison Co., Mich.). Sep 1970. 61p. Dep. CFSTI.

Information concerning radioactive and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

47795 (DOCKET-50341-19) ENRICO FERMI ATOMIC POWER PLANT, UNIT 2. Further Comments on Maximum Probable Water Level. (Detroit Edison Co., Mich.). 18 Sep 1970. 4p. Dep. CFSTI.

47796 (DOCKET-50346-17) DAVIS-BESSE NUCLEAR POWER STATION. Preliminary Safety Analysis Report, Amendment 11. (Toledo Edison Co., Ohio). 11 Sep 1970. 18p. Dep. CFSTI.

47797 (DOCKET-50348-10) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Environmental Statement. (Alabama Power Co., Birmingham). 11 Sep 1970. 74p. (DOCKET-50364-4). Dep. CFSTI.

Information concerning chemical, radioactive, and thermal discharges from the reactor is presented. The effects of reactor operations on the environment are analyzed. (D.C.C.)

47798 (DOCKET-50348-11) JOSEPH M. FARLEY NUCLEAR PLANT, UNITS 1 AND 2. Preliminary Safety Analysis Report, Amendment 5. (Alabama Power Co., Birmingham). 11 Sep 1970. 88p. (DOCKET-50364-5). Dep. CFSTI.

47799 (DOCKET-50361-10) SAN ONOFRE NUCLEAR GENERATING STATION, UNITS 2 AND 3. Preliminary Safety Analysis Report, Amendment 2. (Southern California Edison Co., Los Angeles. San Diego Gas and Electric Co., Calif.). 15 Sep 1970. 264p. (DOCKET-50362-9). Dep. CFSTI.

47800 (DOCKET-50368-2) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Vol. 1. (Arkansas Power and Light Co., Little Rock). 10 Sep 1970. 371p. Dep. CFSTI.

Information on Arkansas Nuclear One Power Reactor Unit 2 is presented under the following broad topics: Introduction and Summary; Site and Environment; Reactor; Reactor Coolant System; Containment System; Engineered Safety Features; and Instrumentation and Control. (D.C.C.)

47801 (DOCKET-50368-3) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Vol. 2. (Arkansas Power and Light Co., Little Rock). 10 Sep 1970. 371p. Dep. CFSTI.

Information on Arkansas Nuclear One Power Reactor Unit 2 is presented under the following broad topics: Electrical Systems; Auxiliary and Emergency Systems; Steam and Power Conversion System; Radioactive Waste and Radiation Protection; Conduct of Operations; Initial Tests and Operations; Safety Analysis; and Technical Specifications. (D.C.C.)

47802 (DOCKET-50368-4) ARKANSAS NUCLEAR ONE, UNIT 2. Preliminary Safety Analysis Report, Vol. 3. (Arkansas Power and Light Co., Little Rock). 10 Sep 1970. 372p. Dep. CFSTI.

Information on Arkansas Nuclear One Power Reactor Unit 2 is presented under the following topics: piping and design equipment; design bases; technical qualifications; AEC proposed general design criteria; quality program; meteorology; surface water hydrology; ground water hydrology; geology; seismology; thermal shock analysis; quenching heat transfer coefficients; containment pressure tests; mechanical splicing of reinforcing bar; quality control of field welding of liner plate; and containment load response test. (D.C.C.)

47803 (NP-18389) PROBLEMS IN DISPOSAL OF WASTE HEAT FROM STEAM-ELECTRIC PLANTS. A STAFF STUDY SUPPORTING THE COMMISSION'S 1970 NATIONAL POWER SURVEY. (Federal Power Commission, Washington, D. C. Bureau of Power). 1969. 53p.

The increasing population and the growing economy of the United States result in demands for electric power that approximately double each decade. The relative scarcity of economical hydroelectric sites, and the unsuccessful efforts to date of on-going research to develop acceptable alternative energy conversion processes to provide the bulk power supplies, indicate that a very high percentage of the power requirements for the foreseeable future will have to be produced by steam-electric plants, nuclear or fossil fueled. Problems related to thermal effluents from nuclear and steam power plants are analyzed. 39 references. (auth)

47804 COOLING TOWER SITE CONSIDERATIONS. DeHarpporte, Dean R. Power Eng.; 74: No. 8, 49-51(Aug 1970).

Meteorological conditions which restrict the siting of nuclear power plants using cooling towers are analyzed. (D.C.C.)

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Refer also to abstract 46307.

47805 (ANL-7610) REACTOR PHYSICS DIVISION ANNUAL REPORT, JULY 1, 1968-JUNE 30, 1969. (Argonne National Lab., Ill.). Jan 1970. Contract W-31-109-eng-38. 542p. Dep. CFSTI.

For abstracts of individual sections see: 47637, 47818, 47877, 47891, and 47934.

47806 (DP-Report-100) REPORT OF WORKING PARTY OF BOARD OF MANAGEMENT ON AN EXTENSION OF THE DRAGON PROJECT AGREEMENT. Project DRAGON. Caprioglio, P.; Fawcett, S.; Franco, G.; Glueckauf, E.; Higatsberger, M. J.; Mogard, H.; Parker, E.; Rennie, C. A.; Shepherd, L. R. (Atomic Energy Establishment, Winfrith (England)). Jun 1962. 35p. Dep. CFSTI (U. S. Sales Only).

The technical and financial aspects of extending the present Dragon Project Agreement to cover a period of five years from April 1962 are discussed, with the specific objective of providing information for the signatories leading to the design of an economic land-based graphite-moderated high temperature reactor. A review of progress on research and development work, details of the proposed technical program for the proposed five year period, an estimate of commitments, and an analysis of professional and technical staff are included. (auth)

47807 (DP-Report-362) REVIEW OF THE ENGINEERING ORGANISATION DURING DESIGN AND CONSTRUCTION OF THE DRAGON REACTOR. Project DRAGON. Franco, G.; Terry, R. L. (Atomic Energy Establishment, Winfrith (England)). Jul 1965. 169p. Dep. CFSTI (U. S. Sales Only).

The Dragon Reactor Experiment was designed, built, and commissioned in the period 1959-1964 as the major object of the OECD High Temperature Reactor Project. The reactor plant was designed and procured by Project staff, the contracts placed by

the UKAEA Contracts Branch at AEE, Winfrith. Project staff produced the broad specifications for the buildings, civil works, and conventional engineering plant, the detailed design and procurement of which was undertaken by the Engineering Group of the UKAEA who undertook direct supervision of site erection of buildings and plant. Organization and methods adopted for these tasks are described and references are made to the work of the Project's Research and Development Division on prototypes and test rigs. Some aspects of the procurement of plant from manufacturers in various countries and the necessary coordination are reviewed. (auth)

47808 (ORNL–4548) MOLTEN-SALT REACTOR PROGRAM. Semiannual Progress Report for Period Ending February 28, 1970. (Oak Ridge National Lab., Tenn.). Aug 1970. Contract W-7405-eng-26. 361p. Dep. CFSTI.

Topics investigated in the molten salt reactor program include: MSRE operations and development; MSBR design and development; chemistry; materials development; and molten salt processing and preparation. A separate abstract was prepared for each of the 5 sections. (H.D.R.)

For abstracts of individual sections see: 46307, 46308, 46692, 47809, and 47810.

47809 (ORNL–4548, pp 1-40) MOLTEN-SALT REACTOR EXPERIMENT. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

HEAT EXCHANGERS—performance of MSRE primary, summary of

MOLTEN SALT REACTOR EXPERIMENT—operations experience during September 1969 to March 1970
- —reactivity balances during operation with uranium–233 fuel, zero power, (E)
- —xenon poisoning under various operating conditions in, (E)
- —noise analyses in, pressure, (E)
- —tritium production rates in, (E/T)
- —fuel system of, fission product distribution in, (E)
- —fuel system of, evaluation of leak in primary
- —fuel salt transfer to overflow tank in, effect of fuel pump level on, (E)
- —fuel salt temperature differences between inlet and points on reactor vessel, (E)
- —power levels in, system heat balance determinations of
- —heat exchanger performance in, (E)
- —components in, thermal cycle history of
- —fuel salt sampler–enricher operation in
- —control rod and drive assemblies for, performance of
- —off-gas systems performance in
- —maintenance during September 1969 to March 1970, remote
- —shutdown and standby status of
- —physics calculations for, use of XSDRN and CITATION codes for
- —reactivity variations in uranium–235 fueled, long-term, (T)
- —fuel system for, thermal cycle tests on freeze flange in
- —xenon poisoning effects in, analytical model for
- —control rod scrams in, summary of (H.D.R.)

47810 (ORNL–4548, pp 41-92) MSBR DESIGN AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

From Molten-Salt Reactor Program.

BERYLLIUM FLUORIDES—BeF_2–LiF–ThF_4–UF_4, properties of MSBR fuel salt, heat transfer and thermophysical

HEAT EXCHANGERS—design parameters of bayonet tube

MOLTEN SALT BREEDER EXPERIMENT—fuel salt pump development for
- —steam generator for, design of tube test stand for
- —design of 1000 MW(e) single fluid
- —heat exchangers for, design parameters of bayonet tube
- —tritium distribution in, effects of various design parameters on, (T)
- —physics parameters of 1000 MW(e) single fluid
- —control system for, analog simulation of
- —fuel salt for, heat transfer and thermophysical properties of
- —power levels in, uranium–235 depletion rate determinations of, (E/T)

WELDING—procedures for pipe, development of remote (H.D.R.)

47811 RCN PROGRAM FOR SODIUM-COOLED FAST REACTORS. Nijs, W. W. Atoomenergie Haar Toepass.; 12: 89-97(Mar 1970). (In Dutch).

The RCN development program for a Na-cooled fast reactor includes: research; development and construction of a prototype; and development and construction of power-production reactors. The large-scale experiments include safety aspects, such as determination of the Doppler coefficient. Double control systems have been developed on the basis of international studies on maximum credible accidents; recent fuel-rod control failures have prompted in-core and meltdown studies. The RCN program includes study of the effect of fission products on the reactor characteristics, causes and consequences of fuel rod failures, behavior of aerosols, and heat transfer characteristics in the core. The fast thermal experiment (STEK) went critical in May 1969; the STEK experiments concerning the safety of the HFR prototype include long-term testing of fuel rods, short-term experiments on rod failure, effects of flux changes and of cooling failure. The latter case will be simulated outside the reactor using explosives with comparable level of energy release. Rods will be heated electrically in experimental Na loops. The experiments concerning the replacement of one of Na and of the steam loop by a single CO_2 loop yielded disappointing results because of the reactivity of CO_2 and Na even below 250°C. (TTT)

47812 LARGE-SCALE ENGINEERING EXPERIMENTS FOR THE DEVELOPMENT AND TESTING OF NUCLEAR POWER PLANT COMPONENTS. Kison, H.; Lochmann, K.; Schad, O. (AEG-Telefunken, Grosswelzheim, Ger.). Atomwirt., Atomtech.; 15: 277-80(Jun 1970). (In German).

Importance of large scale studies is exemplified by development of components for boiling water reactors within West Germany. The objective for large scale experimentation with respect to light water reactors aims at reliability of components, optimal control mechanisms, maximal efficiency through optimizing of individual components, and reduction of risks connected with construction and operation of nuclear power plants. Economy of the plant can be increased only by maximal utilization. The AEG nuclear energy experimental station at Grosswelzheim involves an investment of more than 10,000,000 DM. This investment combined with the frequent necessity for structural changes as well as repeated experimental start-ups and shutdowns results in high costs. (H.B.G.)

47813 FAST BREEDER NUCLEAR REACTOR. (to Combustion Engineering Inc.). British Patent 1,203,107. 26 Aug 1970. Priority date 23 Dec 1966, United States.

REACTORS, BREEDER—design of fast, with checkerboard pattern of seed and blanket regions

REACTORS, FAST—design of breeder, with checkerboard pattern of seed and blanket regions (H.D.R.)

47814 BOR FAST REACTOR. Borisyuk, E. V.; Gryazev, V. M.; Kevrolev, V. P.; Medovshchikov, S. F.; Smirnov, A. M.; Timchenko, V. L. (Scientific Research Inst. of Atomic Reactors, Melekess, USSR). Energ. Nucl. (Paris); 12: 33-8(Jan-Feb 1970). (In French).

The principal features of the 60 MW(t) BOR fast reactor, located at Melekess in the Soviet Union are described. The characteristics of the fuel elements, core control elements, fuel loading machine, cooling system and reactor equipment are discussed. (auth) (France)

47815 MOLTEN SALT CONVERTER REACTOR. Bettis, E. S.; Bauman, H. F. (Oak Ridge National Lab., Tenn.). Power Eng.; 74: No. 8, 42-4(Aug 1970).

Conceptual design parameters for a 1000 MW(e) molten salt converter reactor are presented. Advantages for operating a reactor of this type are discussed. (D.C.C.)

47816 GOVERNMENT/INDUSTRY RELATIONSHIPS IN THE DEVELOPMENT OF REACTORS IN THE US. Tremmel, Ernest B. (Atomic Energy Commission, Washington, D. C.). Neue Tech., B; 11: 104-12(1969).

Some of the more important ways in which the United States Government has fostered the development of peaceful nuclear applications in cooperation with the private sector of the U. S. economy are described. The problems of fuel cycle are discussed from exploring, mining and milling of nuclear fuels to fuel reprocessing. Particular emphasis is given to the breeder program. Some considerations are devoted to the importance of radioisotopes and to the Plowshare Project for peaceful uses of nuclear explosions. (auth)

47817 BOILING WATER REACTOR: DEVELOPMENT AND DEVELOPMENT TENDENCIES. Kornbichler, H. Neue Tech., B; 11: 286-92(1969). (In German).

The improvements realized in the field of boiling water reactors since the first stations of this type went in operation are described. Some possibilities of further developments are discussed. (auth)

Kinetics and Dynamics

47818 (ANL-7610, pp 61-258) FAST REACTOR PHYSICS. (Argonne National Lab., Ill.).
From Reactor Physics Division Annual Report, July 1, 1968-June 30, 1969.

CRITICAL ASSEMBLIES—startup and initial operation of ZPPR, review of
—physics parameters for plutonium fueled ZPR-3
—reactivity worths for ZPR-3 Assembly 50
—physics parameters for ZPR-3 Assemblies 53 and 54
—reactivity measurements in pulsed ZPR-3 Assemblies 53 and 54
—delayed neutron fraction in pulsed ZPR-3 Assemblies 53 and 54
—reactivity heterogeneity effects in ZPR-3 Assembly 53, MACH-1 and CALHET computer program calculations of
—reactivity measurements in ZPR-3 Assembly 53, analysis of graphite density
—design parameters of ZPR-3 Assemblies 55 and 55A
—physics parameters of ZPR-3 Assemblies 55 and 55A
—criticality measurements in ZPR-3 and ZPPR, for FFTF
—design parameters of ZPR-6 Variable Temperature Rodded Zone
—reaction rate calculations for ZPR plate type, (T)
—neutron resonance integrals in slab type, extended equivalence principle for heterogeneous and homogeneous, (T)
—Doppler measurements in uranium oxide (UO_2) fueled ZPR-6 and ZPR-9
—shutdown of fast plutonium fueled, safety parameters for prompt
—control rods for fast plutonium fueled, reactivity worth measurements for
—neutron cross sections for ZPR-3 Assemblies 11 and 48, verification of ENDF/B calculations by
—criticality of plutonium fueled ZPR-3, (E/T)
—gamma spectra for, performance of Compton recoil γ-ray spectroscopy methods for
EXPERIMENTAL BREEDER REACTOR-II—physics parameters of plutonium oxide (PuO_2)-uranium oxide (UO_2) fueled
—radiation dose rate for top of shield
GAMMA RADIATION—spectra in critical assemblies, performance of Compton recoil γ-ray spectroscopy methods for
LIQUID METAL FAST BREEDER REACTOR—physics parameters for, measurements in ZPR-3, ZPR-6, ZPR-9, and ZPPR for analysis of
NEUTRON CROSS SECTIONS—calculations of, critical assemblies verification of ENDF/B
NEUTRONS—resonance integrals for slab type critical assemblies, extended equivalence principle for heterogeneous and homogeneous, (T)
—spectra in soft spectrum fast reactors, measurement of
NEUTRONS, DELAYED—fraction measurements in pulsed ZPR-3 Assemblies 53 and 54
—fraction measurements for fast reactors, effects of neutron spectra on, (E/T)
NEUTRONS, FAST—spectra in uranium metal, (E/T)
PLUTONIUM ISOTOPES Pu-239—capture to fission ratio in, methods for measurement of, (E/T)
—fission cross section ratio measurements from 0.24 to 24 keV
—criticality calculations for unmoderated sphere shaped
PLUTONIUM ISOTOPES Pu-241—delayed neutron parameters for
PLUTONIUM ISOTOPES Pu-242—delayed neutron parameters for
RADIATION DETECTORS, PROPORTIONAL—calibration of proton-recoil, fast neutron spectrum measurements in iron and scandium beams for
REACTIVITY—worth measurements for ZPR-3 Assembly 50
—measurements in pulsed ZPR-3 Assemblies 53 and 54
—heterogeneity effects in ZPR-3 Assembly 53, MACH-1 and CALHET computer program calculations of
—measurements of graphite density, in ZPR-3 Assembly 53
—Doppler measurements in uranium oxide (UO_2) fueled ZPR-6 and ZPR-9
REACTOR CONTROL ELEMENTS—reactivity worth of fast plutonium fueled critical assembly
REACTORS, FAST—physics parameters for 2700 liter uranium carbide (UC) core, comparison of ZPR-6 Assembly 5 measurements and ENDF/B data for
—reactivity worths for, effects of resonance self-shielding on calculation of, (T)
—neutron spectra in soft spectrum measurement of
—delayed neutron fraction for, effects of neutron spectra on, (E/T)
—physics parameters for, effects of neutron cross section calculations on, (E/T)
—criticality calculations for oxide fueled, effects of core configuration on
—physics parameters for cylinder shaped split core, group-space-dependent buckling simulation of two dimensional, (T)
URANIUM ISOTOPES U-233—fission cross section ratio measurements from 0.24 to 24 keV
URANIUM ISOTOPES U-235—capture to fission ratio in, methods for measurement of, (E/T)
—fission cross section ratio measurements from 0.24 to 24 keV
—criticality calculations for unmoderated sphere shaped
URANIUM ISOTOPES U-238—Doppler effect calculations for (D.C.C.)

47819 (ANL-7629) FLUX-CHARACTERIZATION AND NEUTRON-CROSS-SECTION STUDIES IN EBR-II. Dudey, N. D.; Heinrich, R. R. (Argonne National Lab., Ill.). May 1970. Contract W-31-109-eng-38. 23p. Dep. CFSTI.

The current status of flux-characterization studies in EBR-II using foil-activation techniques is reviewed. Activation-rate data are obtained by irradiating monitor foils and radiochemically determining the disintegration rate of each foil at the time of the end of the irradiation. Equations are presented to convert the disintegration rates to activation rates, including corrections for power-level fluctuations. The flux values are determined from a computed spectrum-averaged cross section and the activation rate. The method used to compute spectrum-averaged cross sections from reactor-physics calculations is described briefly. Flux values are compared with reference values, and the deviations are discussed. The principal considerations in using measured flux values involve the compositional changes in EBR-II, and the perturbations in the flux due to heterogeneous effects within the reactor. Measurements at high and low power are compared, the conclusion being that, within the uncertainties of the data, no discrepancy between the flux per megawatt at high and low power is observable. Spectrum-averaged cross sections at four positions in EBR-II are presented for 22 reactions. The ratio of $^{54}Mn/^{55}Fe$ atoms produced from ^{54}Fe is shown to represent a sensitive spectral index for fast-reactor spectra. This index is compared with two spectrum-averaged cross sections measured in 13 different fast-reactor spectra. 15 references. (auth)

47820 (BNWL-1379) EXPERIMENTAL AND CALCULATED RESULTS FOR UO_2 AND UO_2-PuO_2 FUELED H_2O-MODERATED LOADINGS. Loizzo, P.; Martinelli, R.; Pacilio, N.; Williams, L. D.; Edgar, J. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 181p. Dep. CFSTI.

Data collected during a series of experiments in the Plutonium Recycle Critical Facility (PRCF) using plutonium and uranium enriched fuel are presented. The experiments were designed to provide a base for assessing the accuracy of calculational techniques used for designing plutonium enriched cores in boiling water reactors with regard to predicting core reactivities, power distributions, and control system worths. Reactivity and power distribution measurements were made in both single region and multiregion loadings. Calorimetric techniques were used to intercalibrate the different fuel types for the multiregion loadings. The reactivity effect of various control blade materials was determined as a function of the prompt neutron decay rate (Rossi-alpha). Theory-experimental comparisons are based primarily on CNEN developed theoretical models. 28 references. (auth)

47821 (CONF-680980-, pp 87-101) APPLICATION OF NOISE ANALYSIS TO POWER REACTOR CONTROL. Suzuki, Eiji (Power Reactor and Nuclear Fuel Development Corp., Tokyo (Japan)); Nomura, Tsutomu; Tsunoda, Tomio (Nippon Atomic Industry Group Co. Ltd., Tokyo).

One of the kinetic parameters β/l of JPDR (Japan Power Demonstration Reactor) at low power level was effectively measured at 10w power level by means of the two detector correlation method. The method is being extended to determine the shutdown reactivity of the reactor. A stability monitor has been developed which uses a spectrum analyzer with band-pass filter. The monitor has been applied to the reactor. A method for measuring absolute reactor power through neutron fluctuation is proposed, whose applicability is justified by experiments. Development of a Campbell system using fission chamber or ion chamber makes it possible to cover both the source and the intermediate ranges of reactor power with one detector. A reactivity meter has been applied to measure control rod worth of the reactor at power, and reactivity fluctuations have been observed directly by the means of the meter. (auth)

47822 (CONF-680980–, pp 275–83) MEASUREMENT OF TRANSFER FUNCTION BY MEANS OF TRANSIENT RESPONSE EXPERIMENTS AT JPDR. Ezure, Hideo (Japan Atomic Energy Research Inst., Tokai).

Transient response is applied to functional tests and measurement of the transfer function of automatic control circuits. The measurement of transfer functions in power reactors has been unsuccessful, because the power fluctuation is much greater than in research reactors and the mathematical descriptions to analyze the transient response are not firmly established. The response is analyzed by a mathematical description and the effect of noise to signal is decreased. The mathematical description is Fourier transformation by Filton's method. The transfer function of JPDR has been measured at an extent from 0.001 to 0.5 cps. It has been shown that transient response methods are useful in the commercial power reactor. (auth)

47823 (CONF-680980–, pp 337–50) TRANSFER FUNCTION MEASUREMENTS BY ROD OSCILLATOR TESTS AND DYNAMIC ANALYSIS AT JPDR. Hoshi, Tsutao (Japan Atomic Energy Research Inst., Tokai).

Transfer functions including thermal-hydraulic feedback phenomena have been measured with the rod oscillation method in the JPDR, a natural circulation BWR type reactor. Data obtained provide sufficient information for the thermal-hydraulic feedback phenomena and for the space dependency in the core. The most interesting feature in the experiments was that space dependent phenomena of neutron flux is clearly observed at the lower frequency range of 0.01 to 10 cps. (auth)

47824 (LA–4396) 3DDT: A THREE-DIMENSIONAL MULTIGROUP DIFFUSION–BURNUP PROGRAM. Vigil, John C. (Los Alamos Scientific Lab., N. Mex.). Feb 1970. Contract W-7405-eng-36. 41p. Dep. CFSTI.

3DDT is a three-dimensional (X-Y-Z or R-Θ-Z) multigroup diffusion theory code. It can be used to compute k_{eff} or to perform criticality searches on reactor composition, time absorption, or reactor dimensions by either the regular or the adjoint flux equations. Material burnup and fission production buildup can be computed for specified time intervals, and criticality searches can be performed during burnup to compensate for fuel depletion and fission product growth. All programming is in FORTRAN-4 and variable dimensioning is used to make maximum use of available core storage. Because variable dimensioning is used, no simple restrictions can be placed on individual components of the problem. However, a 16-group problem containing 30 × 30 × 30 mesh points and 80 zones can be accommodated on a 65k computer. Execution times are about 0.01 sec per mesh point per group for a k_{eff} calculation on a CDC 6600 computer. (auth)

47825 FAST REACTOR PHYSICS. PART 2. Bustraan, M. Atoomenergie Haar Toepass.; 12: 98–104(Mar 1970). (In Dutch).

The relationship between fission and subsequent fuel conversion ratios, loss of reactor efficiency, rate of breeding and the refueling requirements of fast reactors are examined and compared with similar criteria of thermal reactors. The rapid changes in the reactors are studied; the neutrons last only 1 to 10 μsec in fast reactors and 10 to 100 μsec in thermal ones; however, a fraction of the fission neutrons lasts a much longer period afterwards. This fraction β is an important factor in the control and safety of fast reactors fueled with $^{239}Pu - ^{238}U$. As soon as the breeding factor $k_{eff} > 1 + \beta$, the delayed neutrons are no longer needed to maintain prompt criticality. Relatively small changes in the reactivity may cause a doubling of the reactor output. As mechanical controls are too slow, interacting effects must be employed to correct these changes. In ^{235}U, ^{239}Pu and ^{241}Pu neutron absorption usually results in fission; therefore, because of the Doppler effect, increased temperature will increase somewhat the reactivity. A close thermal contact must be designed into the fuel configuration involving ^{238}U and the fission-heat-generating ^{239}Pu. Loss of sodium or steam from the core affects the Doppler effect. Calculations are rendered difficult because many of the fission product cross sections are not known sufficiently well. Alternate fuel cycles and coolants are also examined, considering the $Th - ^{233}U$ cycle and the best breeding cycle based on ^{238}U in the $^{238}U - ^{233}U$ cycle in Th containers. Cooling with He or CO_2 is also examined. (TTT)

47826 STUDY OF THE DYNAMICS OF A TWO-CIRCUIT NUCLEAR POWER INSTALLATION BY MEANS OF A MODEL. Selivanov, V. M.; Sidorova, I. I.; Gorev, A. A.; Martynov, A. D.; Solopov, A. P.; Shcherbakov, I. E. This paper was summarized in At. Energ. (USSR); 26: 446(May 1969) as paper No. 285. (In Russian).

Some experimental data regarding the starting conditions (modes) of steam generating installations (SGI) and the transition from one level of power to another are presented. At the instant of starting there is no circulation of the heat carrier; reactivity is introduced linearly at a rate of 5×10^{-5} sec^{-1}. This may be regarded as a sudden (sharp) introduction of reactivity for the heating conditions under consideration. The heating was studied for jumps in reactivity ΔK equal to 1×10^{-3}, 0.8×10^{-3}, and 0.5×10^{-3}. When studying the transition of the SGI from one level of power to another, perturbations arising from the turbine were simulated by sharp changes in steam flow, the flow remaining constant after each sharp change. Steam-flow perturbations equal to ±30, ±50, and ±80% of the nominal value were applied for reactivity temperature coefficient of -0.25×10^{-3}, -0.5×10^{-3}, and -1×10^{-3} 1/°C. It follows from the results obtained that, with the reactor operating under self-regulating conditions, and with a certain combination of the separator volume and the circulation time of the water in the first circuit, practically any law of variation of the turbogenerator load may be established. No inadmissible surges of power occur, and the change in steam pressure in the second circuit imposes no limitation on the operation of the turbine. (auth)

47827 DYNAMICS OF A TWO-CIRCUIT INSTALLATION WITH A SELF-REGULATING REACTOR AND NATURAL CIRCULATION OF THE HEAT CARRIER. Orekhov, Yu. I.; Sidorova, I. I.; Kuz'menko, B. A.; Trofimova, N. N.; Filippova, N. V.; Shcherbakov, I. E. This paper was summarized in At. Energ. (USSR); 26: 445–6(May 1969) as paper No. 284. (In Russian).

The problem of determining the dynamic characteristics of a two-circuit steam-producing installation is presented together with some typical results. The installation has the following characteristics: a reactor of the water-cooled water-moderated type operates in the self-regulating mode; the circulation of the heat carrier in the first and second circuits is natural; saturated steam of variable parameters is fed to the turbine; the steam generator is built into the reactor vessel. An installation of this type is intended for a 1.5-MW atomic power station with a heating output of 3.5 Gcal/h. The conditions for the stability of the fundamental harmonic are obtained by the method of concentrated parameters, allowing for the xenon and thermal feedback. It is shown that the stability conditions are not the same for the reactor operating as a part of the whole installation and an isolated reactor (with a power-independent temperature of the heat carrier at the inlet). The dependence of the turbogenerator efficiency on the steam parameters had a strong influence on the stability. The heating conditions of the installation were studied on an analog computer. It is shown that natural circulation is not a limiting factor in effecting the heating; the heating time should be selected from the point of view of the thermal stresses. The law of reactivity variation ensuring a linear rise in the temperature of the installation cannot be fully realized by manual control using compensating units. Transient modes associated with perturbations in steam flow were also studied by an electrical simulation method. The results show that the dynamic characteristics of the installation are satisfactory even for gradual shedding or application of the full external electrical load. The effects of various factors on the quality of the transient processes are indicated; these include the temperature coefficients of reactivity, the water circulation time along the first circuit; and the heating of the water in the reactor. The changes in the principal quantities associated with the heating-up process and with changes in steam flow are illustrated. (auth)

47828 METHOD AND APPARATUS FOR MEASURING THE INFINITE MULTIPLICATION FACTOR OF NUCLEAR REACTOR SYSTEMS. Ghilardotti, Giancarlo; Brighenti, Giuseppe (to SNAM Progetti SpA). U. S. Patent 3,519,534. 7 Jul 1970. Priority date 14 Jul 1966, Italy.

A method and apparatus are described for measuring the infinite multiplication factor of nuclear reactor systems by determining the amount of poison which reduces the infinite multiplication factor (K_∞) to unity with the null reactivity method carried out by the oscillation technique of the pile oscillator method. (AEC)

47829 EXPERIENCE WITH XENON OSCILLATIONS. Graves, W. E. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Nucl. Appl. Technol.; 9: 651–61(Nov 1970).

Xenon spatial flux oscillations can be an operational problem in large reactors operating at high power levels. Empirical experience in controlling such oscillations in Savannah River Plant reactors and in the Shippingport reactor is described. Recent calculation methods are reviewed, with emphasis on digital simulation of reactor performance including explicit representation of control systems and strategies. 26 references. (auth)

47830 NEUTRON-ENERGY SPECTRA FOR FAST REACTOR IRRADIATION EFFECTS. Okrent, D. (Argonne National Lab.,

Ill.); Loewenstein, W. B.; Rossin, A. D.; Smith, A. B.; Zolotar, B. A.; Kalifelz, J. M. Nucl. Appl. Technol.; 9: 454-507(Oct 1970).

The neutron energy spectra of sodium-cooled fast reactors is reviewed, with primary attention given to the neutron energy range from 30 keV to 10 MeV, the major source of irradiation damage in a fast reactor. The status of relevant fast neutron cross section knowledge is examined, and the influence of cross section uncertainties is included in the comparison of theoretical predictions with experiment. Also examined are differences among various theoretical methods and problems in determining the spectrum in real systems with interfaces and heterogeneities. The current status of studies of the EBR-II flux and spectrum is summarized, including determination of absolute flux magnitude and two-dimensional estimates of the considerable influence of neighboring subassemblies and experimental heterogeneity on the very high energy spectrum. Finally, the relationship between flux monitor data, knowledge of spectra, and radiation damage is discussed. 196 references. (auth)

Control Systems

Refer also to abstract 47829.

47831 (CONF-680980-, pp 233-47) MEASUREMENT OF TEMPERATURE NOISE IN AN OUT-OF-PILE HEAT TRANSFER LOOP. Nishihara, Hideaki; Ohtsubo, Akira (Tokyo Univ. (Japan). Dept. of Nuclear Engineering).

Temperature noise, or fluctuation in an out-of-pile heat transfer loop was measured and analysed. Air as the working fluid passed through a round heated steel pipe of 30.0 mm ID with Reynolds numbers 2.5×10^4 and 5.0×10^4. The fluctuating temperature was measured by a fast response thermocouple in thermal entrance region as well as in the thermally developed region at a number of radial positions. Power spectral density, autocorrelation function, amplitude distribution, and the profile of the temperature fluctuation across the flow channel have been analysed. Power spectral density, plotted in terms of the local wave number, was almost identical for different runs. Assumption of alternating random telegraph signal for the fluctuating temperature gave a measure of hot and cold lumps. (auth)

47832 (DP-Report-157) TEMPERATURE MEASUREMENT IN THE DRAGON REACTOR. Project DRAGON. Reichardt, F. A. (Atomic Energy Establishment, Winfrith (England)). May 1963. 35p. Dep. CFSTI (U. S. Sales Only).

The metallurgical work which served as the basis for the selection of thermocouples for the Dragon Reactor is reviewed. The problem of temperature measurement was concerned primarily with the development of thermocouples suitable for operation in the core and reflector environments. (H.D.R.)

47833 (EURFNR-747) THE DEVELOPMENT OF THE SEFOR ENERGY PROBES. Bumm, H.; Glauner, H. W.; Ruehl, E.; Schikarski, W.; Tavosanis, M. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Angewandte Reaktorphysik). Translation of report KFK-1033. 57p. Dep. CFSTI.

Work performed under United States-Euratom Fast Reactor Exchange Program.

The development of the SEFOR energy probes for measurement of power transients is described. Energy probes use the direct temperature increase in fissionable material resulting from nuclear fission for the measurement of the power or the integral temperature change for measurement of the energy in a power excursion. A survey is given on the construction and material technological advancements in the development of the SEP. The determination of the dynamic properties by research in a cyclotron and a research reactor is reported. The SEP's studied have a response time constant which is below the required value of $\tau_A = 1$ msec and a heat conduction constant which is sufficiently large (about 350 msec) so that the measurement is not affected. An extensive discussion of the systematic errors which can occur in the stationary and dynamic operation of the SEP's is given. (tr-auth)

47834 (PEL-200) REACTOR THERMAL POWER INTEGRATOR FOR SAFEGUARDS CONTROL. Developed for the International Atomic Energy Agency. Sligting, D. J.; Du Preez, W. H. (Atomic Energy Board, Pelindaba, Pretoria (South Africa)). Oct 1969. Contract 576/RB. 31p. Dep. CFSTI (U. S. Sales Only).

An instrument which computes and periodically records the integrated thermal power of a water-cooled nuclear reactor over an extended period of time for safeguards control purposes is described. Various philosophical aspects of safeguards control are discussed together with practical problems of implementing an ideal system. The discussion leads to the reasons for adopting the approach used, which involves the use of existing transmitters in the safety channels of the reactor as signal sources for the power integrator. The power integrator accepts standard signals for both $\Delta\tau$ and the coolant flow and, from these variables, computes the time-integral of the reactor power. It also provides printout of integrated power at 24-hour intervals, is capable of unattended operation for at least six months, will not lose information during a power failure, and is completely independent and tamper proof after being sealed. A complete operating and service manual for the instrument is included. (auth)

47835 OPTIMAL CONTROL OF DISTRIBUTED PARAMETER NUCLEAR POWER REACTORS. El-Bassioni, Adel Abdel-Hamid. Ann Arbor, Mich.; Univ. of Michigan (1969). 181p.

Thesis.

The control of a reactor modeled by distributed parameters is analyzed and a closed loop control system is developed. The approach uses the concept of two types of operation, described as tracking and regulator phases. These phases are treated separately due to the difference in time scale and the nature of perturbations involved. In both cases "Modal" and "Nodal" analyses are used to discretize the space dependence. The Pontryagin Maximum Principle is used to determine optimal control. Although most of the effort is concentrated on getting a closed loop control for each phase, an alternative is developed which is an open loop control with magnitude constraints. However the adequacy of such a solution is questionable due to the fact that the approximate dynamic process parameters are not well defined and may change with time, and in addition random disturbances may be present. These factors are treated by including an auxiliary control system with the computed open loop solution. (Diss. Abstr.)

47836 STATIC SYSTEM OF PROGRAMING AND CONTROL OF INSERTION OF CONTROL RODS IN A PRESSURIZED WATER REACTOR. Szlachter, J. (Ateliers de Constructions Electriques, Charleroi, Belg.). Neue Tech., B; 12: 7-12(1970). (In French).

The increase in power of reactors has led to a decrease in the number of control rods that can displace simultaneously, with an increase in their speed of displacement. The control rod assembly in the system described has been divided into groups which are further divided into sub-groups. The rods displace in a discontinuous manner, each sub-group being controlled by a solid-state programmer which ensures a displacement sequence of less than a second. The assembly of sub-groups making up a group is controlled by a master programmer consisting of a logic analogue converter and a distribution circuit for the sending of pulses to the slave programmers. Finally, the control of the rod coils by the slave programmer is carried out by a thyristor system which ensures a constant current mode of operation. This current control reduces the effect of the main cause of speed limitation, i.e., the coil inductance. (auth)

47837 PROSPECTS OF AUTOMATION IN THE CONTROL OF NUCLEAR POWER PLANTS. Panis, L. M. (Brown, Boveri and Cie, Baden, Switzerland). Neue Tech., B; 12: 1-6(1970). (In German).

A well-proven, reliable solid-state system for the automation of turbine-generators and complete power stations, using fixed wired logic elements, is described. If used in conjunction with a digital computer supplied for data processing, the computer could additionally take over subordinate reactor controls or even the overall control of the power station. (auth)

47838 IMPROVEMENTS IN OR RELATING TO MEANS FOR INHIBITING CORROSION OF GRAPHITE ARTICLES IN A NUCLEAR REACTOR. Lind, Robert; Seddon, James Walter; Kline, Robert Allen (to United Kingdom Atomic Energy Authority). British Patent 1,202,213. 12 Aug 1970. Filed 24 Apr 1967.

Reference is made to the use of inhibitors of the CO_2-graphite reaction in gas cooled reactors. Where large blocks of graphite are used in the reactor core the concentration of the inhibitor (usually CH_4) may be lower in inner regions of the blocks, depending on the balance between the rate at which it can diffuse through the blocks and the rate at which it is destroyed by radiolysis. In the arrangement described the graphite blocks are provided with ducts whereby inhibitor can reach the inner regions. Various arrangements for these ducts are described. The size of the ducts is governed by the considerations that they should not give rise to significant reductions in strength in the blocks, that they should not remove significant quantities of graphite from the blocks, and that they do not require to carry large coolant flows. These considerations point to very small ducts (2 to 3 mm diameter), but in practice the size is dependent on the ability to form

the ducts in long lengths of graphite. Keyways may be provided in the outer surface of the blocks. (UK)

47839 CONTROL REACTOR WITH A PROCESS COMPUTER. Hendon, H. H.; Morgan, W. R.; Mitchener, B. E. Power; 114: No. 8, 48-9(Aug 1970).

The use of a process computer along with appropriate reactor instrumentation to provide power distribution data and control for boiling water power reactors is described. (D.C.C.)

47840 METHOD OF CONTROLLING NUCLEAR REACTORS. Rausch, Wilfried (to Brown Boveri/Krupp Reaktorbau GmbH). U. S. Patent 3,519,536. 7 Jul 1970. Filed 2 Aug 1967.

A packed or "pebble bed" reactor is shut down by inserting the control rods directly into the packing of fuel elements. Design parameters of the control rods are presented. (AEC)

47841 OPTIMIZING TEST INTERVALS FOR DETECTING FAILURES IN STAND-BY SYSTEMS. Daublebsky, P. (Allgemeine Elektricitaets-Gesellschaft, Frankfurt am Main). Brennst.-Waerme-Kraft; 22: 283-7(1970). (In German).

A method which makes it possible to shorten the test intervals in the event of partial failure of parallel stand-by system, so as to maintain the required minimum reliability, is discussed. This method is illustrated by the example of a rapid shut-down system for boiling water reactors. (auth)

47842 MOST IMPORTANT CONTROL SYSTEM OF A BOILING-WATER NUCLEAR POWER PLANT. Weehuizen, F. H. J. (Brown Boveri/General Electrical Technical Services Co., Baden, Switzerland). Neue Tech., B; 12: 65-73(1970). (In German).

The systems for the control of the station power and of the feed-water for the reactor are described. The special conditions of a two turbine plant are analyzed. (auth)

47843 NUCLEAR FUEL ASSEMBLY WITH PLURAL INDEPENDENT CONTROL ELEMENTS AND SYSTEM THEREFOR. French, Robert J.; Andrews, Harry N. (to Westinghouse Electric Corp.). U. S. Patent 3,519,535. 7 Jul 1970. Filed 24 Jan 1968.

A nuclear reactor is disclosed which has a plurality of fuel assemblies consisting of commingled fuel rods and guide tubes. A portion of these fuel assemblies have a plurality of two-position control elements or neutron absorbers which can be telescoped within their respective guide tubes. Each individual control element, which may have more than one control module associated therewith, may be removed or inserted independent of the remaining control elements. The reactor can therefore be more efficiently controlled and may be utilized for load follow service. (AEC)

47844 POSSIBILITIES OF AUTOMATION IN THE CONTROL OF NUCLEAR POWER STATIONS. Costantin, P.; Parthier, S.; Schuster, W. Neue Tech., B; 12: 12-16(Feb 1970). (In German).

The aims and requirements of an automatic control system for nuclear power plants are examined. The present state of control is described and future possibilities are discussed. Practice is likely to include double computer systems with reliable modules and automatic fault finding facilities. Fixed wiring redundant system reactor protection is retained. (auth)

47845 BACKUP CONTROL ROD SYSTEM. Germer, John H. (to United States Atomic Energy Commission). U. S. Patent 3,524,924. 18 Aug 1970. Filed 16 Jul 1968.

A backup control rod arrangement is described which functions to shut down a nuclear reactor in the event of failure of the primary control system. During normal operation of the reactor, the backup control rod is maintained in a position beneath the reactor core by suction produced by an electro-magnetic pump or the like. Upon failure of the primary control system or other desired shut down of the reactor, the pump is reversed or inactivated and the control rod is allowed to float upwardly into the reactor core due to the backup rod being less dense than the coolant in the core, which, for example, may be sodium. In addition, the reverse flow of fluid from the electromagnetic pump may be utilized to force the backup rod into the core. (AEC)

47846 NUCLEAR REACTORS. Ebeling, Douglas Roy; Gilbert, Charles Philip (to United Kingdom Atomic Energy Authority). British Patent 1,197,464. 8 Jul 1970. Filed 15 Aug 1967.

Reference is made to reactors of the type in which the fuel is housed in tubes extending vertically through the core and steam is generated in the tubes from water coolant flowing through them. In the system described each tube inlet has individual variable fluid flow restricting means responsive to a signal from the reactor, and the tubes and their restriction means are arranged in groups such that all the restriction means of a selected group are variable simultaneously in the same sense by the same signal. The flow restriction means produce pressure drops across the tube inlets sufficient to suppress instabilities in the tubes and to control coolant flow and voidage. The restricting means may comprise a single valve for each group of tubes, with multiple outlet parts, each part being connected to a tube inlet. The necessary reactor signals may be initiated by neutron flux density, steam pressure, steam quality or coolant temperature sensing instruments. The groups of tubes and valves are preferably arranged in zones, the valves being responsive to a characteristic signal for effecting overall reactor control and a signal for effecting zonal control. (UK)

47847 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Rausch, Wilfried (to Brown Boveri/Krupp Reaktorbau GmbH). British Patent 1,197,461. 8 Jul 1970. Filed 20 Jul 1967.

Reference is made to reactors of the "pebble bed" type. The system described has the object of providing a process which permits the reactivity of a "pebble bed" to be altered without requiring interposing built-in structures in the core. Rod-shaped control or shut-down elements are introduced in such a way as to displace the operating elements (fuel elements, moderator elements, etc.) Penetration of the rod-shaped elements may occur partly by free fall and partly by forced drive, and control may take place through slow penetration by forced drive of at least one of the rod-shaped elements up to a predetermined depth. Emergency shutdown takes place in two stages; in the first stage the rod-shaped elements fall under gravity up to a predetermined depth, and in the second stage forced drive is employed to the final position. A roof reflector may be provided with channels in which the rod-shaped elements are guided and three elements are so supported that they can be lowered without rotational movement. The rod-shaped elements comprise a metal jacket containing a neutron absorber and shaped to facilitate penetration; cooling ribs may be provided. The rod-shaped elements may also have at least one internal passage for cooling gas, leading to perforations in their walls. A vibrational drive means is preferable. (UK)

Shielding

47848 (CEA-N-1331) GAMMA RADIATION ATTENUATION STUDY: ^{16}N LOOP, COMPARISON OF EXPERIMENTAL RESULTS WITH CALCULATION. Dupont, Claude; Jean, Aime; Oceraies, Yves (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Aug 1970. 43p. (In French). Dep. CFSTI (U. S. Sales Only).

An attempt was made to check the methods of calculation used for determining the thickness of the secondary shielding of water cooled reactors. The nitrogen 16 loop situated in the reactor Triton was considered as being a schematic representation of the complex circuits of these reactors. (4 references) (auth) (France)

47849 (CEA-N-1351) STUDY OF THE UPPER SHIELDING OF THE PHENIX REACTOR; COMPARISON BETWEEN S_N AND MONTE CARLO METHODS. Lanore, Jeanne Marie (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). May 1970. 14p. (In French). Dep. CFSTI (U. S. Sales Only).

The neutron attenuation in B_4C solutions, dense graphite and stainless steel were studied using the Monte Carlo POKER code. The results were compared with rough calculations made using the S_N NIOBE code. (auth) (France)

47850 (ORNL-tr-2354) CALCULATION OF THE FLUX IN A SODIUM RESERVOIR. Katz, Shlomo; Nimal, Jean-Claude; Vergnaud, Therese (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated fy R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from report CEA-N-1253. 20p. Dep. CFSTI.

Calculations are made of the different responses given by detectors (S, Rh, Mn/Cd) in the model of the lower shielding of Phenix placed in the reactor Harmonie, using the code Tripoli. The calculation methods make use of sources placed at the entrance of the model. The case considered is a simple one but is typical of the majority of the possibilities offered by the three-dimensional multikinetic Monte-Carlo code Tripoli. Experimental results and calculations for spherical geometry using the code Niobe are also available. (5 references) (auth)

47851 PRESTRESSED CONCRETE PRESSURE VESSEL FOR NUCLEAR REACTOR. Zerna, Wolfgang (to Philipp Holzmann AG). U. S. Patent 3,523,063. 4 Aug 1970. Priority date 26 Aug 1966, Germany.

A method for prestressing concrete vessels to a value of compressive stress on the order of several thousand tons per meter of vessel height is described. Bundles of prestressing cables entirely encircle the vessel, whether cylindrical or spherical, but are not anchored thereto at intermediate points, and the cable ends are joined by a coupling device of material somewhat softer than the cables themselves. Temporary anchors near the ends of the cables are jacked together to apply the desired prestressing tension. Alternatively, the cable ends having the anchors thereon may overlap and the anchors are jacked apart before the clamping device is fastened thereto. In one embodiment, the cables are spaced from the surface of the vessel by bearing boxes spaced along the vessel periphery so that the cable path is polygonal. The bearing boxes slide on a steel sliding plate attached to the vessel wall and interposed therebetween is a sliding sheet of material such as "Teflon." The coupling device and anchors may also bear on such sliding sheets and plates. In a still further embodiment, an auxiliary concrete shell is spaced exteriorly and concentrically from the vessel wall and hot air blown therebetween to reduce the interior–exterior temperature differential and to provide corrosion protection for the prestressing cables. (AEC)

47852 NUCLEAR REACTOR WITH MEANS FOR SEALING REACTOR VESSEL CLOSURE PLUG. Webb, John; Stacey, John (to United Kingdom Atomic Energy Authority). U. S. Patent 3,522,144. 28 Jul 1970. Priority date 24 Feb 1967, Great Britain.

A closure plug for a nuclear reactor vessel has a dip seal adjacent its outer face and a supplementary dip seal adjacent its inner face, the latter having an annular trough for containing the sealing liquid. The trough is thermally insulated for ensuring that in normal operation the liquid is at a temperature less than that of the inner closure plug surface which is exposed to the contents of the vessel. An example involving a sodium-cooled fast reactor and having a mercury outer face dip seal and a sodium inner face dip seal is described. (AEC)

Cooling Systems

47853 (APDA-262) QUARTERLY TECHNICAL PROGRESS REPORT ON AEC-SPONSORED ACTIVITIES, APRIL–JUNE 1970. (Atomic Power Development Associates, Inc., Detroit, Mich.). Contract AT(11-1)-865. 56p. Dep. CFSTI.

Tube wastage by sodium–water reactions in steam generators is analyzed. Test results for Cr–Mo–steel tubes are presented. Acoustic detection devices are described for sodium–water experiments. Impurity monitors for liquid sodium systems are described. A comparison of methods for calculating and measuring heterogeneity effects in fast critical assemblies and power reactors is presented. (D.C.C.)

47854 FAST REACTOR COMPONENTS. Hoekstra, E. K. Atoomenergie Haar Toepass.; 12: 115-21; 124-30(Apr 1970). (In Dutch).

In both thermal and fast reactors the heat generated in the core is transferred to the turbines by one or more circuits and then transformed into mechanical energy. The components of a typical fast reactor are illustrated on the Na-cooled 300 MW(e) DeBeNe-Lux breeder reactor. The different pressures of the two Na circuits and of the water-steam circuit prevented leakage of radioactive Na. Any leaks in the Na heat exchanger must be stopped without removing the pipes; countercurrent cooling is used. The vertical, single-stage pump has a capacity of 5000 m^3/hour; where there is a possibility of contact with Na, a special corrosion-resistant stainless steel is used. The two steam generating units are provided with an evaporator, reheat and double-reheat systems. The 50 MW(t) test installation for heat exchangers and generator was built at Hengelo; the pump loop built at Bensberg will be used to test the Na loops. A steam-cooled fast reactor with six parallel steam circuits was under study by the DeBeNeLux project, but has been abandoned. At present a more modest, 100 MW(e) He-cooled reactor is under construction. The prestressed concrete pressure vessel for this reactor is less expensive than a metal container and presents the advantage that it can be built on the site. The large mass minimizes the chance of a catastrophic failure. The direct gas turbines are expected to be more efficient than the indirect steam turbines. Impurities in the He may cause serious corrosion problems, therefore the gas must be kept free from contamination and must be purified if required. (TTT)

47855 PROGRAM FOR FAST REACTOR TECHNOLOGY AT TNO. de Haas van Dorsser, A. H. Atoomenergie Haar Toepass.; 12: 131-7(Apr 1970). (In Dutch).

A 243 MW heat exchanger, a 50 MW steam generator and a 5000 m^3/hour Na pump are developed under the program. Study of the heat exchanger for the SNR (fast, sodium-cooled reactor) revealed that replacement of the second Na circuit by CO_2 would be too expensive. Thermal shock tests of welded joints were successful; initial leakage of O-ring seals after mechanical shock was overcome. An experimental 280 m^3/ hour vertical Na pump with free Na level and Na-lubricated bearings was operated satisfactorily at 650°C. Corrosion research work is aimed at the understanding of mass transfer phenomena of the alloying elements, such as the transfer of carbon from the unstabilized ferrites to the austenite; the effect of oxygen on cermets and solders is also under study. The abrasion of ferritic materials at temperatures above 500°C in coatings, fuel rods and bearings is examined. It was found that metal fatigue is lowest at 500 to 600°C. Tests were carried out on the weldability of niobium-stabilized chromium-molybdenum alloys. The program includes study of the effects and the detection of hydrogen, oxygen and other contaminants. (TTT)

47856 FLUID CIRCULATOR. Yampolsky, Jack S.; Bell, Francis R.; Fortescue, Peter (to United States Atomic Energy Commission). U. S. Patent 3,520,640. 14 Jul 1970. Filed 6 Sep 1966.

A fluid circulator is described incorporating rotary elements for establishing a fluid flow. A drive shaft rotates the rotary elements, and is driven by a first turbine portion and a second turbine portion, each of which is independently operable to rotate the drive shaft from separate sources of pressurized driving fluid. (AEC)

47857 INVESTIGATION OF HEAT-TRANSFER CRISIS IN A BUNCH OF FUEL ELEMENT SIMULATORS UNDER NATURAL CIRCULATION CONDITIONS. Zenkevich, B. A.; Peskov, O. L.; Sapankevich, A. This paper was summarized in At. Energ. (USSR); 26: 446-7(May 1969) as paper No. 286. (In Russian).

The results of experiments on the heat-transfer crisis in natural water circulation in a bunch of simulators of twisted strip fuel elements in the reactor of the ABV-1.5 plant are presented. An analysis of the theoretical as well as experimental investigations of the heat transfer crisis in boiling coolant flow shows that the reliability of reactor operation can presently be estimated only on the basis of full-scale experiments. An expression for calculating the critical power of a single fuel element was obtained by computer processing of the results of the experiments. The expression can be used for the following parameters: pressure, 6–80 atm abs.; temperature of the water entering the bunch, 30–270°C; mass velocity, 200–900 kg/m^2 · sec; fuel element length, 0.2–0.6 m. Good agreement was observed between the data for simulators with uniform heat release and with stepwise heat release, which simulated the heat release in a reactor. This made it possible to use the expression for estimating the margin to the heat transfer crisis in the reactor core with respect to the power level. (auth)

47858 SINGLE- AND TWO-PHASE PRESSURE DROPS ON A 16-ROD BUNDLE. Grillo, P.; Marinelli, V. (Comitato Nazionale Energia Nucleare, Rome). Nucl. Appl. Technol.; 9: 682-93(Nov 1970).

The results obtained from coolant pressure drop measurements, conducted on a test section comprising 16 rods in a square arrangement, are analyzed. The rod bundle, mechanically assembled by means of two end plates and five grid spacers located at different axial stations, was mounted in a vertical heat-insulated pressure vessel. The measurements, taken under isothermal and adiabatic conditions, covered the following range of coolant parameters: relative pressure p_g = 0 psi; subcooling = 135 and 108°F; mass velocities between 0.5×10^6 and 5.6×10^6 lb/hr ft^2; and relative pressure p_g = 450 psi; subcooling = 144 and 72°F; mass velocities between 0.5×10^6 and 2.5×10^6 lb/hr ft^2; steam quality between 2 and 22%. The main results obtained are for single phase flow: the continuous friction factor falls about 10% short of the corresponding value predicted by Moody's correlation for smooth pipes and load loss coefficients at the constraints, i.e., end plates and spacer grid, result depending on the Reynolds number. For two phase flow: the continuous friction multiplier factor shows a strong dependence on the coolant mass velocity and the load loss coefficients at the constraints can be explained by a calculation model based on a slip variation hypothesis. (auth)

47859 SODIUM PROCESS INSTRUMENTATION FOR THE DOUNREAY PFR. Duncombe, E.; Thomasson, R. K. (United Kingdom Atomic Energy Authority, Risley, Eng.). Nucl. Eng. Int.; 15: 714-17(Sep 1970).

The salient features of the Na process monitoring system and the functions of the individual instruments are described for both primary and secondary circuits of the PFR. Processes involved include monitoring of Na level, flow, bearing performance and delivery pressure of pumps, plugging temperature, impurity levels, and leak detection. (UK)

47860 INSULATED DUCTS FOR NUCLEAR REACTORS. Germer, John (to United States Atomic Energy Commission). U. S. Patent 3,525,669. 25 Aug 1970. Filed 2 Oct 1968.

A means is described for insulating ducts in a tank type sodium reactor to reduce the structural stress caused by temperature differences and sudden temperature changes. This is accomplished by providing a gas insulation sleeve about the critical stress areas with appropriate seal rings adjacent the connector areas which allows expansion and contraction of the structure while substantially reducing structural stress. (AEC)

Fuels

Refer also to abstracts 46302, 46306, and 46769.

47861 ACHIEVING HIGH EXPOSURE IN METALLIC URANIUM FUEL ELEMENTS. Leggett, R. D. (Battelle-Northwest, Richland, Wash.); Marshall, R. K.; Hann, C. R.; McGilton, C. H. Nucl. Appl. Technol.; 9: 673-81(Nov 1970).

Experimental metallic uranium fuel elements were irradiated under power reactor conditions to greater than 18,000 MWd/T with no indication that an exposure limit was being approached. This excellent performance is attributed to providing an axial hole in the fuel to accommodate fuel swelling internally without increasing the external dimensions of the fuel element. The irradiation test was conducted in the Engineering Test Reactor (ETR) in 260°C, 2000 psi water with coextruded, Zr-2 clad, uranium rods. An axial hole representing 5, 10, or 20 per cent of the fuel volume was provided in the center of the fuel and was sealed from the coolant by a brazed and welded Zr-2 end cap. Other variables in the test included cladding thickness and composition. The length, diameter, warp, and volume of each of 24 test elements were measured each reactor cycle in the ETR canal, and periodic neutron radiographs were obtained. Based on examinations of the neutron radiographs, it is concluded that the axial hole acted as originally intended and permitted an increase in the allowable exposures of a uranium rod by at least a factor of five and potentially much more. If 2 percent strain is allowed in the Zr-2 clad, the rods with 5, 10, and 20 percent holes would be expected to survive exposures to a maximum of about 25,000, 40,000, and 70,000 MWd/T, respectively. (auth)

47862 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Japan Atomic Energy Research Inst.). British Patent 1,202,920. 19 Aug 1970. Priority date 23 Dec 1966, Japan.

REACTOR FUEL ELEMENTS — design parameters of vented rod type, for fission product gas removal (D.C.C.)

47863 NUCLEAR REACTOR FUEL ELEMENT ASSEMBLIES. Martin, Dudley James Victor (to United Kingdom Atomic Energy Authority). british Patent 1,201,051. 5 Aug 1970. Filed 4 Sep 1967.

Reference is made to cluster type fuel element assemblies. In reactors employing such assemblies the outermost rods of an assembly tend towards a higher heat output, because of their proximity to the moderator, and they also shield the remaining rods from thermalized neutrons. In order not to exceed a maximum safe working temperature for the outermost rods the channel is operated at a power level less than optimum. In previous attempts to equalize the operating temperatures of the fuel rods the outermost rods have either been of smaller girth than the remaining rods, or of lower fissile richness. The assembly described comprises a cluster of spaced, parallel, sheathed fuel rods having a substantially uniform content of fissile material, but the rods are arranged in inner and outer groups, the rods of the outer group being tubular for coolant flow and of greater girth than the solid rods of the inner group. The tubular rods have a larger surface area for cooling, and temperature variation across the fuel is small relative to that of solid fuel rods of the same mass. Therefore the power output of the tubular outermost rods may be equal to or greater than that of the solid rods and the operating temperatures of all the fuel rods of the cluster are substantially equalized at a maximum safe working temperature. (UK)

47864 NUCLEAR REACTOR. Rigg, Shepherd (to United Kingdom Atomic Energy Authority). British Patent 1,200,561. 29 Jul 1970. Filed 22 Apr 1968.

Reference is made to nuclear reactors wherein a core barrel is used to carry a core supporting diagrid, such as in smaller sizes of BWR and PWR's. In such reactors problems arise due to thermal stresses, and the barrel is normally profiled to give some degree of stress relieving flexibility. The system described is based on the realization that the conventional welded joint between the barrel and diagrid was over-rigid and aggravated the problems. The core barrel member carries a core support diagrid member having rounded projections on the barrel that engage registering recesses in the diagrid member. This provides the means whereby the diagrid is carried by the barrel. The rounded projections may comprise threaded screws mounted in the barrel member. These screws have domed ends to engage the recesses in the diagrid member. (UK)

47865 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Shennan, John Vincent; Ford, Lionel Houston (to United Kingdom Atomic Energy Authority). British Patent 1,199,051. 15 Jul 1970. Filed 22 Mar 1967.

Reference is made to coated particle fuels of the type comprising pyrolytic carbon coated uranium carbide. The object of the method described is the production of coated particles in which the gap produced between the UC_2 kernel and the outer coating is less than the minimum size which can be achieved by the methods, thus allowing a higher U concentration, and also giving UC_2 kernels of higher density. An initial coating of pyrolytic carbon is applied to carbide particles having a carbon content exceeding that of UC and extending up to $UC_{1.6}$. The deposition temperature is such that reaction between the coating and the particles does not occur to an appreciable extent. An outer coating of a fission product retaining refractory material is then applied at a higher temperature, such that reaction occurs between the initial coating and the uranium carbide particles to form $UC_{1.85}$, and voidage in the form of a gap is produced between the particles and the coating. The initial coating is preferably deposited at 1000° to 1400°C and the outer coating at above 1450°C. The initial layer may also be deposited to a greater thickness than required for conversion to dicarbide, whereby a residual inner layer of carbon remains as part of the coating. The initial carbon may be deposited by pyrolysis of methane or acetylene. (UK)

Auxiliary and Emergency Systems

47866 (CEA-N-1356) STUDY OF THE BURST SLUG DETECTION METHODS. Melichar, Zdenek (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Jun 1970. 64p. (In French). Dep. CFSTI (U. S. Sales Only).

The detection of a burst slug in a power reactor must occur in the least possible time. A study was made of the various methods of surveillance of the Saint Laurent 1 reactor: mechanical filtration, electrostatic collection (continuous and delayed), and total γ radiation measurements. Only the first two methods, which are essentially similar to delayed neutrons measurements, lead to sufficiently short response times. (26 references) (auth) (France)

47867 (GEAP-10092) PERFORMANCE OF MOLYBDENUM FILAMENTS IN BWR EMERGENCY COOLING HEAT TRANSFER TESTS. Duncan, J. D.; Bock, R. G. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov 1969. Contract AT(10-1)-1230; Subcontract S-7044. 37p. Dep. CFSTI.

For Idaho Nuclear Corp., Idaho Falls.

The performance of molybdenum filaments as fuel rod simulator heating elements in BWR emergency cooling heat transfer tests has been evaluated. Analysis of test data and a simplified analytical model indicates that molybdenum's high temperature coefficient of electrical resistivity causes a nontypical spatial power distribution in test bundles. Molybdenum is therefore not suitable for use in emergency cooling heat transfer tests intended to demonstrate the thermal performance of BWR fuel rods during a loss-of-coolant accident temperature transient. The high temperature capability of molybdenum can be exploited in tests directed at the determination of Zircaloy cladding performance under high temperature emergency cooling conditions. The results of such tests can not be interpreted as being representative of the thermal performance of BWR fuel bundles undergoing loss-of-coolant accident/emergency cooling transients. (auth)

47868 (GEAP-10117) RESPONSE OF A SIMULATED BWR FUEL BUNDLE COOLED BY FLOODING UNDER LOSS-OF-COOLANT CONDITIONS. Duncan, J. D.; Leonard, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Dec 1969. Contract AT(10-1)-1230; Subcontract S-7044. 36p. Dep. CFSTI.

For Idaho Nuclear Corp., Idaho Falls.

The cooling effectiveness of bottom-flooding a BWR fuel assembly during loss-of-normal coolant has been investigated. Simulated loss-of-coolant transient tests were conducted with a full-scale electrically heated bundle at atmospheric pressure. The temperature response of the bundle was obtained as a function of power level, initial temperature, and coolant flow rate. The results are consistent with those obtained by other investigators, and they demonstrate that this cooling method is effective as a standby cooling system to protect a reactor core in the unlikely event of a loss-of-coolant accident. (auth)

47869 (GEAP-13086) HEAT TRANSFER IN A SIMULATED BWR FUEL BUNDLE COOLED BY SPRAY UNDER LOSS-OF-COOLANT CONDITIONS. Duncan, J. D.; Leonard, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jun 1970. Contract AT(10-1)-1230; Subcontract S-7044. 68p. Dep. CFSTI.

For Idaho Nuclear Corp., Idaho Falls.

The ability of the General Electric core spray system to limit fuel rod cladding temperatures in the unlikely event of a loss-of-coolant accident has been investigated. Simulated loss-of-coolant transient tests were conducted with a full-scale, electrically heated, stainless steel-clad, fuel bundle mockup at atmospheric pressure. The temperature response of the bundle cladding was measured as a function of power level, initial temperature, and coolant spray flow rate. Convective heat transfer film coefficients were then calculated as a function of rod location in the bundle and time after initiation of spray cooling. A tentative physical description of the heat transfer mechanisms significant in spray cooling transients is presented. The results indicate that spray cooling is an effective heat transfer mechanism and that such a system is suitable for use as a standby cooling system to protect a BWR core in the event of a loss-of-coolant accident. (18 references) (auth)

47870 (RT/ING-(70)7) FISSION PRODUCT REMOVAL FROM THE COVER GAS OF A VENTED FUEL FBR. Barilli, L.; Bruzzi, L.; Shorrock, J. C. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 16 Mar 1970. 25p. (CONF-691104-5). Dep. CFSTI (U. S. Sales Only).

From International Congress on the Diffusion of Fission Products, Saclay, France.

The feasibility of a clean-up system for the cover gas of a fast reactor operating with vented fuel is studied. Both helium and argon have been considered as cover gas; physical adsorption methods of Kr and Xe on activated charcoal at low temperature have been used for the purification of gas. The clean-up system is composed of four purification units: the first three beds, which operate in breakthrough, have been designed to delay ^{133}Xe and to remove decay heat; the fourth, which operates as a trap, provides for the removal of the remaining isotopes. A purification flow rate of 5.5 cover gas changes/hour has been chosen in order to obtain a reduction factor 1000 in the cover gas specific activity. 4 references. (auth)

47871 EFFECTS OF NUCLEAR FACTORS ON THE DESIGN OF ELECTRICAL CABLES FOR POWER STATIONS. Verstraete, P. (Bonnard and Gardel, Ingenieurs-Conseils SA, Lausanne, Switzerland). Neue Tech., B; 10: 185-90(1968). (In French).

After a comparison between the electrical installations of conventional thermal plants and those of nuclear power plants, several aspects concerning the electrical installations in nuclear plants are discussed: effects of radiations, complexity of electrical installations and introduction of cables into the containment area. (auth)

47872 NUCLEAR REACTORS. Long, Everett; Shaw, Michael Kevin (to English Electric Co., Ltd.). British Patent 1,199,823. 22 Jul 1970. Filed 12 Mar 1968.

Reference is made to reactors having a number of standpipes penetrating the reactor vessel for the purpose of fueling and other operations to be carried out on groups of fuel channels in the core. Each standpipe is normally closed by a removable shield plug, and in each fuel channel at least one fuel element carries a thermocouple connected to measuring equipment outside the reactor vessel. Conventional means for passage of the connecting cable through the standpipe plug are briefly mentioned, with attendant disadvantages. In the arrangement described a special charge chute is provided, together with means for winding a fuel element fitted with a thermocouple between the fuel channel and the charge chute. An electric cable connection extends through the charge chute, connected at one end to the thermocouple and at the other end to a cable termination which, when the shield plug is in position, is readily accessible to enable connection to the temperature measuring apparatus, the arrangement being such that the shield plug can be removed without disconnecting the cable connection. Where it is desired to mount the thermocoupled fuel element in an intermediate position in the fuel channel, the length of the channel above this fuel element may be occupied by dummy elements, all of the elements being mounted on a harness suspended from the winding means. The dummy elements may be filled with a neutron absorbing material to control the neutron flux level in adjacent fuel channels. Multiple special charge chutes may be employed. (UK)

47873 MECHANICAL HANDLING APPARATUS FOR REFUELING NUCLEAR REACTORS. Bellinger, Ronald; Wills, Stanley Charles Frederick (to Strachan and Henshaw Ltd.). British Patent 1,198,832. 15 Jul 1970. Filed 5 Sep 1967.

Reference is made to fuel element handling apparatus for liquid metal cooled reactors. The object of the system described is to provide a construction which overcomes the difficulties of liquid metal immersed systems. The system comprises relatively movable parts joined together at pivot points. A liquid excluding casing of heat resisting material is provided to enclose the system. The pivot points have liquid excluding flexible portions. These flexible portions may consist of metallic bellows. The casing may be pressurised for the purpose of preventing ingress of liquid in the event of the seal not being perfect. The mechanism for actuation of the movable parts may also be enclosed in the casing. (UK)

47874 A SAFETY DEVICE FOR A NUCLEAR REACTOR. Migne, Jean; Redondo, Vincent; Tribout, Marcel (to Commissariat a l'Energie Atomique). British Patent 1,201,694. 12 Aug 1970. Priority date 18 Aug 1967, France.

REACTOR — shutdown system for, design parameters of horizontal gas propelled rod (D.C.C.)

Operation and Economics

47875 SYSTEM-KONFORMAL OPTIMIZATION OF REACTOR CAMPAIGNS AND UPKEEP TURNS. Marx, D.; Steinbock, P. (Technische Univ., Dresden). Kernenergie; 13: 101-4(Apr 1970). (In German).

On the necessity of optimizing economic campaign periods as the integral constituent in upkeep cycle optimization, the principal factors to be considered as well as the aim function of optimizing upkeep cycles are presented. A study of the economic regimes of operation and its representation as a function of turnaround time provide practical information. (6 references) (auth)

Safety and Siting

Refer also to abstract 47938.

47876 (AI-AEC-12977) AEROSOL MODELING OF HYPOTHETICAL LMFBR ACCIDENTS. Koontz, R. L.; Baurmash, L.; Greenfield, M. A.; Nelson, C. T.; Hausknecht, D. F.; Vaughan, E. U.; Silberberg, M.; Morewitz, H. A. (Atomics International, Canoga Park, Calif.). 31 Aug 1970. Contract AT(04-3)-701. 86p. Dep. CFSTI.

A description of an aerosol model (HAA-3) which is consistent with existing experimental data and which can be defended for use in design or licensing of LMFBR's is presented. Comparison of theory and experiments performed in a vessel whose height is typical of LMFBR inner containment are presented for four independent time varying parameters. A detailed justification of the model and the application of various model assumptions and parameters to accident conditions is described. A description is presented of additional aerosol behavior characteristics suggested by experimental data or analytical considerations, which are not completely resolved. The potential effects of these characteristics are evaluated by parameter sensitivity evaluation with the model. 46 references. (auth)

47877 (ANL-7610, pp 259-367) FAST REACTOR SAFETY. (Argonne National Lab., Ill.).

From Reactor Physics Division Annual Report, July 1, 1968-June 30, 1969.

ALKALI METAL ALLOYS AND SYSTEMS — properties of vapors, calculation of thermodynamic and transport, (T)
ENGINEERING TEST REACTOR — fuel element assembly for, safety analysis and irradiation testing of uranium oxide (UO_2)
EXPERIMENTAL BREEDER REACTOR-II — fuel elements for, TREAT testing of overpower or coolant loss conditions for — fuel elements for, performance of plutonium oxide (PuO_2)-uranium oxide (UO_2) pin type
HODOSCOPES — design parameters of TREAT fast neutron — performance of TREAT fast neutron

IN-PILE LOOPS—testing of TREAT Mark 2, description of proof
—performance of TREAT Mark 2, oxide meltdown
—stress loading of TREAT Mark 2, calculation of sodium slug impact, (T)
LIQUID METAL FAST BREEDER REACTOR—core of, safety analysis of, (E/T)
—coolant boiling in 1000 MW(e) oxide fueled, analysis of transients for
—coolant superheating in, effects of radiation on, (T)
—development of, safety test facilities requirements for
PLUTONIUM CARBIDES—PuC–UC, heat transfer in particle shaped, effects of reactor accident conditions on
REACTOR CONTAINMENT STRUCTURES—leak testing for, effects of temperature sensor radiation heating on errors in, (T)
REACTOR CONTAINMENT SYSTEMS—leak rate measurements for pressurized water ice condenser pressure suppression
REACTOR FUEL ELEMENTS—meltdown of stainless steel clad liquid sodium cooled uranium oxide (UO_2) rod type, use of TREAT for testing
—deformation of uranium oxide (UO_2), effects of transients on, (E/T)
REACTOR SAFETY—accidents in fast reactors, analysis of potential
—coolant boiling in liquid sodium cooled reactors, SAS1A computer program calculations of
—coolant boiling in 1000 MW(e) oxide fueled LMFBR, analysis of transients for
—power excursions in fast breeder reactors, analysis of coupled hydrodynamic–neutronic, (T)
REACTOR SAFETY EXPERIMENTS—experimental facilities of TREAT, description of proof testing for Mark 2 sodium loop
—experimental facilities of TREAT, oxide meltdown performance in Mark 2 sodium loop
—experimental facilities of TREAT, sodium slug impact stress loading of Mark 2 sodium loop, (T)
—instrumentation for TREAT, performance of fuel element motion detection
—instrumentation for TREAT, design and performance of fast neutron hodoscope
—core for TREAT, physics parameters of fast neutron converter region
—fuel elements of TREAT, meltdown testing of uranium oxide (UO_2) S-3
REACTORS, BREEDER—power excursions in fast, analysis of coupled hydrodynamic–neutronic, (T)
REACTORS, FAST—safety analysis for
—coolant boiling in liquid sodium cooled, SAS1A computer program calculations of
—power excursions in breeder, analysis of coupled hydrodynamic–neutronic, (T)
—fuel elements of, effects of transients on deformation of uranium oxide (UO_2), (E/T)
—fuels of, effects of accident conditions on heat transfer of plutonium carbide (PuC)–uranium carbide (UC) particle shaped
REACTORS, PRESSURIZED-WATER—containment system for, leak rate measurements for ice condenser pressure suppression
SODIUM—superheating of liquid, effects of radiation on
URANIUM CARBIDES—PuC–UC, heat transfer in particle shaped, effects of reactor accident conditions on
URANIUM OXIDES UO_2—thermodynamic properties of, effects of melting on, (T) (D.C.C.)

47878 (DOCKET-50231-56) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. License No. DR-15; Technical Specifications Proposed Change No. 3, Addendum. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 8 Sep 1970. 6p. Dep. CFSTI.

Revised technical specifications are proposed that will permit operations at 22 MW(t) with test fuel rods in the innermost refueling ports of the core. (D.C.C.)

47879 (EURFNR-748) THEORETICAL TREATMENT OF CONCEIVABLE SERIOUS ACCIDENTS AT FAST BREEDER REACTORS IN THE CONTEXT OF THE BETHE–TAIT METHOD. Kluge, F. G.; Thurnay, K. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik). Translation of report KFK-1057. 75p. Dep. CFSTI.

Work Performed under United States–Euratom Fast Reactor Exchange Program.

The maximum energy release following a large accident of the fast power reactor is usually calculated with the Bethe–Tait formalism. The version presented is adopted to spherical and to cylindrical geometries; the excursion calculations take account of the delayed neutrons and of the Doppler-feedback, including the fuel-melting process. A formalism for determining the destructive energy is also incorporated. Parameter calculations have been carried out to cover up the uncertainties in the initial values of the excursions; the results are presented and discussed. A critical survey on the main assumptions of the Bethe–Tait formalism has been added. (20 references) (auth)

47880 (GEAP-5536) PRESSURE SUPPRESSION/GRAVITY FLOODING CONTAINMENT SYSTEM FOR METROPOLITAN SITING OF LARGE POWER REACTORS. Sutherland, W. A.; Hench, J. E.; Murray, J. L. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sep 1967. Subcontract C-610. 78p. Dep. CFSTI.

For Phillips Petroleum Co., Idaho Falls, Idaho.

A new containment system concept which provides a passive means for cooling the reactor core following a loss-of-coolant accident is described. This concept utilizes pressure suppression for quickly reducing drywell pressure and, in addition, incorporates a gravity flooding technique for automatically cooling the core. Pressure suppression/gravity flooding is a natural extension of existing technology to meet the need for improved containment systems for metropolitan siting of large power reactors. The study reflects a systems approach to nuclear reactor containment and a safety design philosophy of prompt, aggressive action to arrest and contain an accident early in the transient. (auth)

47881 (IN-1320) NUCLEAR SAFETY PROGRAM DIVISION QUARTERLY TECHNICAL REPORT, OCTOBER 1–DECEMBER 31, 1969. Dietz, K. A. (ed.) (Idaho Nuclear Corp., Idaho Falls). Aug 1970. Contract AT(10-1)-1230. 64p. Dep. CFSTI.

ADSORBENTS—testing of particulate iodine
FISSION PRODUCTS—release of noble gas, in uranium oxide (UO_2) rod type fuel elements, (E/T)
REACTOR CONTAINMENT STRUCTURES—pressure distribution in pressurized water power reactor, effects of coolant loss conditions on, (T)
REACTOR FUEL ELEMENTS—heat transfer in bundle type water cooled, RAHDT computer program for radiation
—fission products in uranium oxide (UO_2) rod type, release of noble gas, (E/T)
REACTOR SAFETY—coolant loss conditions in pressurized water power reactor, analysis of mass and energy distribution for, (T)
—emergency core cooling system for pressurized water power reactors, effects of partial core blockage on performance of, (E)
REACTORS, BOILING—fuel element assemblies for power, RAHDT computer program for radiation heat transfer in bundle type
REACTORS, POWER—fuel element assemblies for boiling, RAHDT computer program for radiation heat transfer in bundle type
—coolant loss conditions in pressurized water, comparison of calculation methods for mass and energy distribution for
—emergency core cooling system for pressurized water, effects of partial core blockage on performance of, (E)
REACTORS, PRESSURIZED-WATER—coolant loss conditions in power, comparison of calculation methods for mass and energy distribution for
—emergency core cooling system for power, effects of partial core blockage on performance of, (E) (D.C.C.)

47882 (NP-18423) PATUXENT THERMAL STUDIES. Summary and Recommendations. Special Report No. 1. Mihursky, Joseph A. (Maryland Univ., Solomons. Natural Resources Inst.). Jan 1969. 20p.

The results of a study on the effects of heated water outfall into the Patuxent River are presented. The principal source of heated effluents in the area of study is a large coal fired power plant at Chalk Point, Maryland. 82 references. (H.D.R.)

47883 (RT/ING-(70)2) UNCONTROLLABLE PROMPT CRITICAL EXCURSIONS IN A FAST REACTOR COOLED BY SODIUM. Dominici, G.; Tavoni, R. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 2 Feb 1970. 37p. (In Italian). Dep. CFSTI (U. S. Sales Only).

In order to define the Design Basis Accident for the PCC fast reactor, the amount of destructive energy that can be released at the end of a nuclear excursion due to the insertion of an infinite reactivity ramp has been calculated. A detailed analysis has allowed an evaluation of how the inserted ramp and the main

reactor characteristics can influence the transient under examination. The study has been carried out under both the conditions of sodium initially inside the core and totally absent from the core. (auth)

47884 ONE- AND TWO-PHASE COOLANT LOAD-LOSS MEASUREMENTS IN A 16-ROD BUNDLE. Grillo, P.; Marinelli, V. Com. Naz. Energ. Nucl., Notiz.; 16: 63-74(Jun 1970). (In Italian).

An analysis of the results obtained from coolant load loss measurements carried out on a square-lattice 16-rod test section at the Studsvik Heat Exchange Laboratory is presented. The rod bundle, mechanically assembled by means of 2 end plates and 5 spacers located at different axial positions, was mounted in a vertical heat-insulated pressure vessel. The measurements, carried out under isothermal and adiabatic conditions, covered the following range of coolant parameters: O Atm relative pressure, mass velocity between $0.5 \cdot 10^6$ and $5.6 \cdot 10^6$ lb/hr ft^2, and subcooling between 135 and 108°F; 30 Atm relative pressure, mass velocity between $0.5 \cdot 10^6$ and $2.5 \cdot 10^6$ lb/h ft^2, and subcooling between 144 and 72°F; and steam quality from 2% to 22%. (9 references) (auth)

47885 TRITIUM PRODUCTION FROM NITROGEN IN FISSION REACTORS. Kincaid, G. P.; Ibert, E. R. (Texas A and M Univ., College Station). Nature (London); 226: 139-41(11 Apr 1970).

It is stated that theory cannot at present account for all the tritium produced in nuclear reactors. One reason may be that reactor water circulating in contact with overlying air is saturated with N_2, which reacts with fast neutrons. High pressure N_2 may also be employed as a primary heat exchanger in some types of reactors, giving another source of tritium. These possibilities led to the study described. An (n,T) reaction on ^{14}N to the ground state of ^{12}C is energetically possible with fast neutrons above 5.6 MeV, which is within the range of fission neutrons. Saturated aqueous NH_4NO_3 solutions were irradiated with reactor neutrons using polyethylene or quartz vials. The contents of each vial were then washed into a counting vial with a suitable scintillant. Gamma ray spectrometry showed γ-activity in each sample caused by neutron activation of impurities and final β-activity counting was carried out by liquid scintillation spectrometry after microdistillation to remove impurities. Data are given as activity per unit volume, and the cross section for triton emission was calculated as 44 mb. The build-up of tritium in the reactor pool was monitored for 72 days. Inventory calculations were made for the reactions $^{14}N(n,T)^{12}C$ and $^2H(n,\gamma)^3H$. The calculated tritium production by the former reaction presupposed that in becoming degraded from 10 to 7 MeV the fission neutrons were capable of travelling over half the distance between the fuel plates (0.31 cm). Approximately 98% of the total tritium produced was lost from the pool water. The calculations did not include tritium production from Li impurities in the core and stainless steel, or boron burnable poison, and the inventory was probably low. It is concluded that tritium production must be considered in any reactor installation using high pressure N_2 as a primary heat exchanger. (UK)

47886 EXPERIMENTAL STUDY OF ACCURACY OF LEAK RATE TEST FOR REACTOR CONTAINMENT VESSEL. LEAK RATE TEST BY ABSOLUTE TEMPERATURE-PRESSURE METHOD. Yamaguchi, T.; Fukue, H.; Shigematsu, H. (Mitsubishi Heavy Industries, Ltd., Kobe, Japan). Mitsubishi Juko Giho; 7: 303-11(May 1970). (In Japanese).

There are two methods of leak rate testing for reactor containment vessels of nuclear power plants: the absolute temperature-pressure method and the reference system method. The absolute temperature-pressure method is simpler and more practical than the reference system method in procedure and equipment used. Leak rate tests on a model of a reduced scale of $^1/_{10}$ of Mihama No. 1 reactor containment vessel by this method were compared with the calculated leak rate. The result of the measurement was applied to the result of a leak rate test carried out at the time of the completion of Mihama No. 1 reactor containment vessel and it was confirmed that this method can be used with sufficient accuracy for a leak rate test. (auth) (Japan)

47887 PREDICTION OF THE INCIPIENT BOILING CONDITIONS FOLLOWING A BLOCKED LMFBR SUBASSEMBLY ACCIDENT. Singer, Ralph M.; Holtz, Robert E. (Argonne National Lab., Ill.). Nucl. Appl. Technol.; 9: 767-70(Nov 1970).

The pressure-temperature history model of incipient boiling of liquid alkali metals is applied to a single subassembly blockage accident of a liquid-metal cooled, fast breeder reactor (LMFBR) where boiling is caused by a sudden flow stoppage with continued heating. The model predicts that the maximum superheat that would be expected to occur under most LMFBR operating conditions for this type of accident is 50 to 100°C. Several mechanisms are indicated, however, that can reduce this value, such as failed fuel, entrained gas, etc. (auth)

47888 SAFETY FEATURES, RELIABILITY, AND ECONOMIC ASPECTS OF NUCLEAR REACTORS. Furet, Jacques (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Automatisme; 15: 339-50(Jul-Aug 1970). (In French).

As a result of the accident prevention studied, normalization, construction codes, and the test criteria introduced into the nuclear industry, the likelihood of accidents has been greatly reduced. The economics of safety are important. The present accident prevention procedure was briefly reviewed, in particular reliability, maintenance, economic aspects, and operational risks were discussed. Methods of fault diagnosis and verification were studied; the role of the human factor was mentioned. (auth) (France)

Power Conversion Systems

Refer also to abstracts 47854 and 47855.

47889 VAPOR GENERATOR FOR USE IN A NUCLEAR REACTOR. Bell, Francis R.; Quade, Robert N. (to United States Atomic Energy Commission). U. S. Patent 3,520,356. 14 Jul 1970. Filed 22 Sep 1966.

A vapor generator is described for use in a nuclear reactor having a circulating coolant. The vapor generator comprises a plurality of fluid conducting heat exchanger tubes each having two sections of materials with different thermal coefficients of expansion. The sections are welded together end-to-end and the tubes are of a material such that the weld is positioned behind a baffle which deflects the flowing coolant in the reactor. (AEC)

47890 NUCLEAR REACTORS OPERATING IN CONJUNCTION WITH GAS TURBINES. Thompson, John; Vaughan, Roger Davison (to Nuclear Power Group, Ltd.). British Patent 1,199,357. 22 Jul 1970. Filed 27 Sep 1968.

It is known that as the operating temperature of gas-cooled nuclear reactors is increased the use of gas turbines to convert the heat developed into useful work becomes increasingly attractive; the smaller size of a gas turbine plant, coupled with the elimination of steam boilers, can result in substantial savings in capital cost. An object of the system described is to keep the number of ducts interconnecting the various operating members of the plant to a minimum and also provide access for removal of components with a minimum number and size of penetrations. The system includes a closed cycle gas turbine plant having at least one compressor driven by a compressor turbine, at least one work turbine on a separate shaft, coupled to an electrical generator, and at least one heat exchanger for heating the working fluid. The plant incorporates ducts for conveying the working fluid in a closed path through the compressor, through one side of the heat exchanger, then through the reactor, through the compressor turbine and work turbine, and thence through the other side of the heat exchanger before reentering the compressor. The compressor turbine and compressor are arranged vertically within a cavity of the concrete pressure vessel, the heat exchanger in a second vertical cavity, the reactor core in a third vertical cavity, and the work turbine in a fourth cavity extending transversely across the pressure vessel. The four cavities are interconnected for the passage of working fluid, and the fourth cavity may intersect the first and second. The generator may also be located in the fourth cavity. (UK)

Research and Test Reactors

Refer also to abstracts 46770, 46814, 47805, 47818, 47877, 47881, and 47983.

47891 (ANL-7610, pp 369-464) EXPERIMENTAL TECHNIQUES AND FACILITIES. (Argonne National Lab., Ill.).

From Reactor Physics Division Annual Report, July 1, 1968–June 30, 1969.

ARGONNE BIOLOGICAL RESEARCH REACTOR—modification of, physics analyses and shielding design and analysis for
COMPUTERS—circuitry development for small digital
CRITICAL ASSEMBLIES—control system for ZPPR, data collection and input–output systems for on-line computer
—fuel inventory procedures for ZPPR, automated
—counting facilities for ZPPR, automated
—neutron reaction rates in cells of fast, methods for measurement of

— neutron fraction measurements in fast, methods for effective delayed
— reactivity measurements in plutonium fueled, precision of servo-control techniques for
— control element for ZPR-6, computer calibration of fine autorod
— neutron spectra in plutonium fueled fast, electronic systems for proton recoil counter measurements of
DATA PROCESSING SYSTEMS— testing of analog to digital converters, automatic
— count rate acquisition by, processing loss reduction in on-line or off-line
FISSION PRODUCTS— yield determination in fast reactor spectra, γ radiation analysis techniques for
FOILS— counting of neutron activated gold, thickness correction factors for
— mass of thin fission, methods for determination of
GOLD— counting of neutron activated foils, thickness correction factors for
MICROSCOPES— control for scanning fission track plates, digital computer method for
NEUTRON SPECTROMETERS— performance of liquid organic
NEUTRONS— reaction rates in fast reactor cells, methods for measurement of
NEUTRONS, DELAYED— fraction measurements in fast critical assemblies, methods for effective
NEUTRONS, FAST— spectra measurements with proton recoil counters, effects of geometrical distortions on
— spectra in uranium-235 fueled fast reactors, comparison of proton recoil counter and time-of-flight, (E)
— spectra in plutonium fueled fast assemblies, electronic systems for proton recoil counter measurements of
— detection of, design of detector systems for
PREAMPLIFIERS— development for proton recoil proportional counting of neutron spectra
RADIATION DETECTORS, ACTIVATION— design of vanadium bath, for fast neutron detection
— efficiency of grey, in neutron intermediate energy range
RADIATION DETECTORS, CHERENKOV— design of gas, for reactor power monitoring
RADIATION DETECTORS, PROPORTIONAL— performance in spectroscopic measurements, electric field effects on
RADIATION DETECTORS, SCINTILLATION— circuit design for liquid organic, for fast neutron detection
— performance of double-chamber gas, for fast neutron fission cross section measurements
RADIATION RATE METERS— performance of digital count, statistical
— design of continuous digital linear
REACTIVITY— measurements in plutonium fueled assemblies, precision of servo-control techniques for
REACTOR EXPERIMENTAL FACILITIES— development for measurement of integral reactor physics parameters
REACTORS, FAST— neutron spectra in uranium-235 fueled, comparison of proton recoil counter and time-of-flight, (E)
— safety surveillance count channels for, statistical performance of
REACTORS, POWER— power of, design of gas Cherenkov monitor for
VAN DE GRAAFF ACCELERATORS— energy calibration measurements on Argonne (H.D.R.)

47892 (BNWL-1200-4) SODIUM TECHNOLOGY QUARTERLY REPORT, APRIL-JUNE 1970. Wykoff, W. R. (ed.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 143p. Dep. CFSTI.

CORROSION LOOPS— design parameters of liquid sodium
FAST FLUX TEST FACILITY— cooling system for, development of sodium purity monitors for
— coolant for, effects of corrosion products and fission products on radioactivity levels in liquid sodium
— coolant for, development of purification system for liquid sodium
— coolant for, chemical analysis of liquid sodium
— fuel elements for, failure monitoring systems for
REACTOR FUEL ELEMENTS— failure of liquid sodium cooled, monitoring system for
SODIUM— impurities in liquid, development of monitors for
— fission product transport in liquid, calculation of radiation levels from
— corrosion product transport in liquid, calculation of radiation levels from
— corrosive effects on Type 304 stainless steel
— purification system for liquid
— chemical analysis of liquid sodium
STAINLESS STEEL— corrosion by liquid sodium of Type 304
THORIUM OXIDES ThO_2— ThO_2–Y_2O_3, fabrication of tube shaped
— ThO_2–Y_2O_3, compatibility testing of liquid sodium
— ThO_2–Y_2O_3, electrical conductivity of
YTTRIUM OXIDES— ThO_2–Y_2O_3, fabrication of tube shaped
— ThO_2–Y_2O_3, compatibility testing of liquid sodium
— ThO_2–Y_2O_3, electrical conductivity of (D.C.C.)

47893 (BNWL-1314) JUSTIFICATION AND SPECIFICATION FOR AN FTR OSCILLATOR. Sheff, James R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 39p. Dep. CFSTI.

The study and the conclusions of an investigation into the need for the measurement of the reactor transfer function of the Fast Test Reactor (FTR) are reviewed. A definition of how often the measurement should be made is presented. A study of the methods available for measuring such transfer functions is included. The methods are evaluated and the oscillator method was selected as the method most appropriate. 7 references. (auth)

47894 (BNWL-1418) FABRICATION OF MARK II PROTOTYPIC FFTF FUEL SUBASSEMBLY FOR SODIUM FLOW TEST. Myers, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 103p. Dep. CFSTI.

Fabrication of a prototypic model FFTF Mark II fuel subassembly is described. The subassembly is comprised of 217 fuel pins assembled into a hexagonal array with top and bottom grid arrangements holding the pin bundle inside a hexagonal flow duct. The pins are 0.230 in. diameter by 90 in. long and each is wrapped with a 0.056-in. diameter 20% cold-work wire on a 12-in. pitch. All materials in the pin bundle in contact with sodium are of Type 316 SS. The duct and nosepiece material is Type 304 SS. (auth)

47895 (BNWL-1461) FFTF IRRADIATION TEST PROGRAM, PRELIMINARY. Finch, L. M. (comp.) (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 106p. Dep. CFSTI.

A preliminary "FFTF Irradiation Test Program" has been prepared as an initial definition of the first in-reactor irradiation experiments in the FTR. The general program description is appended with more detailed, but tentative, test plans. Appendices also compare the designed test capability against required test capability and evaluate the open test positions for tests and reactor performance optimization. (auth)

47896 (BNWL-1487) DETERMINATION OF THE ABSOLUTE NEUTRON FLUX SPECTRUM IN THE PCTR FAST NEUTRON CAVITY FROM MULTIPLE FOIL ACTIVATION MEASUREMENTS. Newman, D. F. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 138p. Dep. CFSTI.

A large Fast Neutron Cavity (FNC), which permits the flexibility of altering the neutron spectrum, has been developed and operated in the central region of the Physical Constants Testing Reactor (PCTR). Analysis of multiple foil activation measurements in the center of the FNC was made to obtain a set of infinitely dilute saturated activities for twenty-six reactions. Activation responses of these foils included the entire range of possible neutron energies in the FNC. The SAND-II code was used for neutron spectrum determination from the experimental data. Neutron spectrum results unfolded from the multiple foil activation data were compared with proton recoil spectrometer measurements, in the center of the FNC, and with reactor theory calculations for this fast-thermal coupled reactor. (43 references) (auth)

47897 (BNWL-SA-2954) DESIGN FOR MATERIAL RADIATION DAMAGE IN THE FFTF. Finch, L. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug 1970. Contract AT(45-1)-1830. 20p. (CONF-691102-26). Dep. CFSTI.

From 17th Conference on Remote Systems Technology, San Francisco, Calif.

A design philosophy was evolved for Fast Test Reactor (FTR) to accommodate unknown structural material damage resulting from high fluence, fast neutron irradiation. Three damage categories of increasing stringency are proposed with concurrently stringent analytical requirements. Examples are cited of pertinent design problems arising from radiation damage to fast reactor structures. (auth)

47898 (CEA-CONF-1569) THE APPLICATION OF A COMPUTER IN THE CENTRALIZED TREATMENT OF MEASUREMENTS AND SIGNALS RECEIVED FROM THE OSIRIS EXPERIMENTAL REACTOR. Corre, Jean; Dupuy, Jean (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 16p. (In French). (CONF-700533-1). Dep. CFSTI (U. S. Sales Only).

From Symposium on Computing and Industrial Automation, Nice, France.

The role of a digital computer in utilizing the various necessary information required for the running of the OSIRIS research reactor is described. The principal parameters treated are: nuclear measurements, thermodynamic measurements, radioprotection measurements and measurements arising from experiments, and signals. The function fulfilled by the computer and its characteristics, its mode of operation and its programming are described. (auth) (France)

47899 (CEA-CONF-1570) IRRADIATION DEVICES USED IN FRENCH RESEARCH REACTORS. Lerouge, Bernard (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). 1970. 20p. (In French). (CONF-700622-1). Dep. CFSTI (U. S. Sales Only).

From French Technical Week Meeting, Belgrade, Yugoslavia.

Irradiation devices are principally used in research concerning the development of power reactors and their fuels. The associated technical problems are: corrosion, neutron absorption, induced heating effects and control. Specific problems concerning capsule and loop devices and the associated materials were considered. It was found necessary to use a very wide range of techniques. (auth) (France)

47900 (CEA-N-1265) AUTOMATIC TRANSFER OF MATERIAL FROM THE REACTOR CORE AND VARIOUS ASSOCIATED PROBLEMS. Fremion, Lucien (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Mar 1970. 14p. (In French). Dep. CFSTI (U. S. Sales Only).

Experimental observations on short lived isotopes must be accomplished in the least time possible. These isotopes are obtained very rapidly from the core of the reactor using pneumatic methods. Sometimes the isotopes are present in such small concentrations that it is necessary to work with large quantities of active material; extensive shielding is required to protect the worker. It is for this reason that a fully automatic protecting manipulator was built. (auth) (France)

47901 (CONF-680980-, pp 71-85) PSEUDORANDOM PULSE PROPAGATION IN SUBCRITICAL NUCLEAR SYSTEMS. Uhrig, Robert E. (Florida Univ., Gainesville. Coll of Engineering); Ohanian, M. J. (Florida Univ., Gainesville. Dept. of Nuclear Engineering Sciences).

Pseudorandom noise measurements were carried out on a number of nuclear assemblies at the University of Florida. These include a light-water-moderated, natural uranium subcritical assembly, a heavy-water-moderated natural uranium subcritical assembly, the University of Florida Training Reactor (UFTR), the University of Florida Accelerator Pulsed Assembly (UFAPA-a light-water-moderated, unreflected, fully enriched subcritical assembly), and very recently the University of Florida SPERT Assembly (UFSA-a slightly enriched uranium oxide fuelled light-water-moderated, slightly subcritical assembly, large in one dimension). The primary purpose of the measurements was to experimentally verify the theoretically calculated spatially-dependent transfer functions, to develop the pseudorandom pulsing technique as a means of measuring shutdown reactivity, to compare experimentally pseudorandom measurements with pulsed neutron measurements, and to study neutron disturbance propagation in a system with core materials representative of those used in present-day nuclear power plants. (auth)

47902 (CONF-680980-, pp 267-74) APPLICATION OF THE PSEUDO RANDOM BINARY SIGNALS TO JRR-3 HIGH POWER DYNAMICS MEASUREMENS. Hara, Masao; Usui, Hozumi; Fujii, Yoshio; Suda, Nobuhide (Japan Atomic Energy Research Inst., Tokai).

The maximum period sequence binary signal has been applied to the measurements of the JRR-3 frequency response at 10 MW. Three measurements have been made to cover the frequency range of 0.003 to 10 radians/sec. The measurements were readily made when the reactor temperature is in equilibrium. Even when it was not, and the reactor power was varying slowly, a power drift compensating system made it possible to carry out accurate measurements. The results obtained under equilibrium and non-equilibrium conditions agreed well. A simple mathematical model has been used to predict the JRR-3 high power dynamics. The frequency response computed with the use of this model also agreed fairly well with the experimental data. (auth)

47903 (DOCKET-50184-22) NATIONAL BUREAU OF STANDARDS REACTOR. Operations Report No. 9, April-June 1970. (National Bureau of Standards, Washington, D. C.). 3 Sep 1970. 14p. Dep. CFSTI.

47904 (DOCKET-50231-54) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR. Furnace-Sensitized Stainless Steel Components in the Primary Coolant System. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). 14 Sep 1970. 4p. Dep. CFSTI.

47905 (NYO-1859-16) NUCLEAR REACTOR FACILITY. Fifteenth Annual Progress Report, July 1, 1969-June 30, 1970. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). Jun 1970. Contract AT(30-1)-1859. 62p. Dep. CFSTI.

Operations and maintenance requirements for the Penn State TRIGA Reactor are presented. Research projects conducted in the facility are described. (D.C.C.)

47906 (ORO-4014-1) ANNUAL PROGRESS REPORT OF THE UNIVERSITY OF FLORIDA TRAINING REACTOR, JULY 1, 1969-JUNE 30, 1970. Englehart, Richard W. (Florida Univ., Gainesville. Engineering and Industrial Experiment Station). Sep 1970. Contract AT(40-1)-4014. 52p. Dep. CFSTI.

The administrative and operational responsibility for the reactor is described, and operating statistics for July, August, and September 1969 are presented. The rest of the report period was taken up by repair and renovation work, principally the repair of a primary cooling system leak. (H.D.R.)

47907 (RT/ING-(70)6) SHORT-TIME IRRADIATION EXPERIMENT IN THE STUDSVIK R-2 REACTOR. Project Criteria: Partial Calculations. Calza Bini, A.; Nobili, A.; Rotoloni, P.; Testa, G. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 24 Feb 1970. 35p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The short-time irradiation experiments to be carried out in R-2 Studsvik Reactor under the Plutonium Programme are described. The 27 first group samples are 5% W/O in Zr-2 cans (pellets and vibrocompacted power). A detailed description of the experiment and the expected in-pile behavior of the samples is presented. A comparison between the results obtained with both CNEN and AB Atomenergi calculation codes is given. (auth)

47908 (SGAE-PH-97/1970) MAGNETIC SHIELDING SYSTEM FOR A REACTOR BEAM TUBE. Dobrozemsky, R. (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). [1969]. 16p. (CONF-700503-7). Dep. CFSTI (U. S. Sales Only).

From 3rd International Conference on Magnet Technology, Hamburg, Germany.

For an experiment on neutron decay, a tangential reactor beam tube with low electric and magnetic fields inside is necessary. In designing reactor beam tubes containing a magnetic shielding system, many problems caused by the presence of the reactor radiation and the small cross section of the beam tube have to be solved. The shielding consists of about 60 parts, mainly tubes with constant diameter, made from soft magnetic material of high permeability. The small cross section of the beam tube, requirements of ultra high vacuum and special surface requirements, yielded a number of technological problems, for example the coupling of a double layer shield from air into ultra high vacuum. Experiments concerning the configuration of the internal magnetic field at critical points and also the improvement of the shielding factor when using a-c-demagnetization are described. 7 references. (auth)

47909 (ZJE-78) SKODA ZERO POWER CRITICAL ASSEMBLY SR-OA. Fleischhans, J.; Kott, J.; Zbytovsky, A. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 9p. Dep. CFSTI (U. S. Sales Only).

The purpose of the reactor is discussed. A description of the reactor is presented. (auth)

47910 LOCAL PILE OSCILLATOR AS A DEVICE FOR MEASURING TEMPERATURE DEPENDENCE IN EPITHERMAL-NEUTRON ABSORPTION. Dekker, Arij Leendert. Delft, Netherlands; Technological Univ. of Delft (1969).

Thesis.

An analysis of the usability of a "local reactor oscillator" for the measurement of epithermal-neutron absorption, the so-called resonance absorption, in fissionable and fertile materials is presented. The major activities can be summarized as follows: (1) The design and building of a local oscillator in the thermal column of the Hoger Onderwijs Reactor at Delft and the calibration of it by means of gold-lead rods. (2) The determination of the epithermal-neutron spectrum in the oscillator channel with very thin

foils obtained by vacuum evaporation and consisting of nuclides with pronounced resonances at specific neutron energies. Single foils as well as multi-material ("plural") foils were used. (3) The development of a number of computer programs in the field of epithermal-neutron absorption. The codes ERIC-II, ZUT, and RIFF RAFF were transcripted into ALGOL—to adapt them to the TR-4 computer—and were further elaborated resulting in ERIDEL and RIFF RAFF. The codes were compared with each other. (4) The computation of resonance integrals and Doppler coefficients for neutron absorption in ^{233}U, natural uranium metal, $^{238}UO_2$, natural uranium dioxyde and thorium metal and the comparison of the results thereof with data from literature sources. Furthermore, the recomputation of these values taking into account the efficiency characteristic ($1/\sqrt{E}$) of the detector. (5) The determination of the oscillator results at room temperature and for a temperature rise from 300° up to 900° or 1100°K for three series of sample rods (natural uranium, thorium and natural uranium dioxyde) each set consisting of 6 to 8 specimens. The results of the investigations are presented. (Diss. Abstr.)

47911 SODIUM-COOLED FAST-FLUX TEST REACTOR. de Boisblanc, Deslonde R. (to United States Atomic Energy Commission). U. S. Patent 3,518,163. 30 Jun 1970. Filed 4 Apr 1968.

A sodium-cooled fast-flux test reactor including a core consisting of an array of hexagonal fuel tubes tilted to conform to a split truncated cone is described. A plurality of vertical closed test loops are arranged in a vertical plane bisecting the conical reactor core. (AEC)

47912 INTERMEDIATE-NEUTRON SPECTRA IN THE EXPERIMENTAL CHANNELS OF A WATER-COOLED, WATER-MODERATED REACTOR. Starodubtsev, S. V.; Vainshtein, G. M.; Stryapunin, V. B. This paper was summarized in At. Energ. (USSR); 26: 449(May 1969) as paper No. 291. (In Russian).

The intermediate-neutron spectra in the vertical and horizontal channels of the VVR-S reactor were measured with resonance detectors. A reference superthermal neutron spectrum, the well-known spectrum $\varphi(E) \sim 1/E$, in a graphite prism 1000 × 1000 × 1000 mm³ in size, was used for comparison (in the vertical channel of the thermal column). A selection of resonance detectors permitting measurement of neutron spectra in the 1–10,000 eV neutron energy range was used. The samples were chosen rather thin to avoid interference with the spectrum. Subtraction of the 1/v contribution and resonance blocking were used to measure the epithermal neutron spectrum in the vertical experimental channel. Only the 1/v subtraction was used in the horizontal channel and the thermal column. The standard spectrum in the graphite prism coincided with the calculated $\varphi(E) \sim 1/E$, while the measured intermediate-neutron spectra in the horizontal and vertical channels deviated somewhat from the 1/E law, because these measurements were made in regions of nonuniform neutron accumulation. The error in the measurements was 20%. (auth)

47913 FLOWING SODIUM CAPSULES IN THE GETR. Brown, D. L. (General Electric Co., Sunnyvale, Calif.); Tunnell, G. W. Nucl. Appl. Technol.; 9: 716-21(Nov 1970).

The development of a facility to conduct fuel tests in a flowing metal environment in a thermal test reactor is discussed. This facility allows fuel tests to be conducted at coolant velocities, powers, and temperature levels which represent operating conditions for both Liquid Metal Fast Breeder Reactors (LMFBR) and space nuclear power stations. The experiment vehicle takes the form of a capsule in which concentric annuli provide a closed loop coolant flow path. The flexibility of the design allows particular experiments to meet specifications within wide ranges of power and temperature level, coolant flow rate, and neutron flux and spectrum. These capsules are suitable for a variety of tests, ranging from long exposures at a steady operating point to cyclic and transient experiments related to safety studies. (auth)

47914 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Everson, Ivor; George, Maurice William (to United Kingdom Atomic Energy Authority). British Patent 1,204,314. 3 Sep 1970. Filed 21 Sep 1966.

Reference is made to materials testing reactors. In such reactors it is customary to handle fuel elements and vertical in-core experiments from above the reactor, and the experimental equipment is therefore handled more frequently than is strictly necessary from the experimenter's point of view since it must be unloaded to permit fuel changing. It is also present practice to change fuel elements individually, and on account of the experimental equipment the time required for refueling tends to be prolonged, with reduction of the reactor utilization factor. The object of the system described is to minimize the shut-down time for fuel changing. The reactor vessel has an "operating station" which comprises neutron reflector means to render the core inherently critical when positioned at this station, and a second "non-operating station" located away from the reflector means, at which position the core is inherently sub-critical. Core transfer means are provided to move the core between the two stations. The second station may provide a fuel element load and unload station, and the transfer means may have a storage and/or core assembling position. The moveable member of the transfer means may comprise at least one arm capable of vertical and rotational movement; this arm is preferably horizontal and arranged to rotate in a horizontal plane so that the core may be moved vertically from the "operating station" and then moved in a horizontal plane to the storage and/or core assembling station. The moveable member may also comprise a number of arms, and is preferably hollow, to form a coolant duct to the core, with valve means for proportioning the flow of coolant. The reflector may be annular in construction. (UK)

Rocket and Space Reactors

Refer also to abstract 46433.

47915 (ANSC-1) WATER DROPLET SIZE DETERMINATION FOR BREAK UP OF LARGE DIAMETER JETS. NERVA Program. (Aerojet Nuclear Systems Co., Sacramento, Calif.). May 1970. Contract SNP-1. 131p. Dep. CFSTI.

A series of nozzle tests in a wind tunnel has improved the understanding of how water from spray and penetration nozzles is distributed in a cross flow of gas, and how water-droplet sizes are generated. The drops generated by the break up of water jets from nozzles ranging in diameter from 0.25 to 1.5 in. were photographed in a series of wind-tunnel tests. The volume mean drop size generated in these tests compared favorably with that calculated using the empirical equation generated by Ingebo for nozzles of from 0.01 to 0.04-in. in diameter. The maximum droplet diameter was nominally 30% smaller than the droplets measured with the Ingebo method. A series of mass-distribution measurements has resulted in a new understanding of the quantity of water removed from the water jet as it penetrates a cross flow of gas. An empirical expression is presented that characterizes the water-jet mass distribution in a cross flow of gas. A series of tests of flat-spray nozzles indicates that the penetration is decreased to 50 or 60% of that attained with a penetration or fire-hose nozzle. 10 references. (auth)

47916 COMPARISONS OF MONTE CARLO CALCULATIONS TO MEASUREMENTS OF NEUTRON LEAKAGE FROM THE TSF-SNAP REACTOR. Cain, V. R. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng.; 41: 310-15(Aug 1970).

Experimental and analytical determinations were made of the neutron radiation leaving the lower surface of a modified SNAP-2 reactor installed at the Tower Shielding Facility. Detailed data on the energy and angular distribution of neutrons leaving an area of about 10% of the reactor lower surface are presented. (H.D.R.)

47917 TWO-PHASE FLUID CONTROL SYSTEM. Brown, Norman J. (to United States Atomic Energy Commission). U. S. Patent 3,525,670. 25 Aug 1970. Filed 17 Dec 1968.

A closed loop, two-phase fluid control system for a nuclear space reactor is described. The control system consists of a vessel disposed in the core region of the reactor and having an internal capillary structure gradient for coalescing a liquid phase neutronic reactive fluid into a continuous liquid body; a condenser external to the reactor core for respectively condensing and cooling the vapor and liquid phases of the fluid exiting from the vessel, an external regulator for controlling the flow rate of the liquid phase fluid into the vessel, and an external pressure regulator for controlling the vapor pressure of the vapor phase fluid in the vessel. (AEC)

Process Heat and Desalination Reactors

47918 NUCLEAR REACTORS AND CHEMICAL INDUSTRY. Tabata, Yoneho (Tokyo Univ.). Sekiyu To Sekiyu Kagaku; 14: No. 2, 72-9(Feb 1970). (In Japanese).

The recent development in the safety and economy of nuclear power generation is increasingly encouraging the multi-purpose utilization of the energy produced in nuclear reactors, and the cost reduction and technical innovation in chemical industry, desalination, and iron manufacture are going to be realized. The reduction of power cost due to the increase in the size of reactors is analyzed. The examples of multi-purpose uses seen in various

countries are described. The gasification of coal and oil and the direct utilization of heat for iron manufacture are discussed. Compared to the indirect use of nuclear energy the direct utilization of nuclear energy from nuclear reactors is very attractive. The utilization of the following radiation and the chemical reaction involved in it are explained: γ ray, fast neutrons and γ ray together, the recoil particles in nuclear reaction, and fission fragments. (Japan)

47919 METHODOLOGICAL ASPECTS OF CALCULATING THE EFFICIENCIES OF ATOMIC DISTILLATION PLANTS. Koryakin, Yu. I.; Loginov, A. A.; Chernyaev, V. A. This paper was summarized in At. Energ. (USSR); 27: 47-8(Jul 1969) as paper No. 312/5090. (In Russian).

The bases for calculations of the economic efficiency—the total expenditures—for dual-purpose atomic distillation plants are described, and analytic expressions for the distribution of the total expenditure among the individual types of production at atomic thermoelectric centers, which furnish heat for distillation, are given. Current methods for distributing the total production costs for the combined production of electrical energy and heat are reviewed, and their main features are analyzed. The following methods are discussed: the isolation method, the factor method, the physical method, the conservation method, the "exergetic" method, the thermodynamic method, and the underproduction method. The analysis permits formulation of a generalized method. This method, like the physical one, takes into account the structure of the overall cost of production at atomic thermoelectric centers; like the "exergetic" and thermodynamic methods, it makes the price of heat a function of its potential; and, finally, like the underproduction method, it takes into account the actual operation of the steam in the energetic cycle. (auth)

Marine and Portable Power Reactors

47920 (DOCKET-50238-67) N. S. SAVANNAH. Malfunction of Emergency Diesel Generator Starting Motor. (First Atomic Ship Transport, Inc., New York). 11 Sep 1970. 3p. Dep. CFSTI.

47921 (DOCKET-50238-68) N. S. SAVANNAH. Malfunction of Air Operated Valves Due to Diaphragm Leakage. (First Atomic Ship Transport, Inc., New York). 14 Sep 1970; Revised 16 Sep 1970. 4p. Dep. CFSTI.

47922 (DOCKET-50238-69) N. S. SAVANNAH. Malfunction of the Emergency Cooling System Due to Faulty Relay. (First Atomic Ship Transport, Inc., New York). 9 Sep 1970. 2p. Dep. CFSTI.

47923 (DOCKET-50238-70) N. S. SAVANNAH. Small Leak Discovered and Patched Temporarily in Coolant Pump. (First Atomic Ship Transport, Inc., New York). 10 Sep 1970. 2p. Dep. CFSTI.

47924 (DOCKET-50238-71) N. S. SAVANNAH. Additions and Corrections to Letters Requesting Transfer of License from FAST to MarAd. (Maritime Administration, Washington, D. C.). Sep 1970. 15p. Dep. CFSTI.

47925 (DOCKET-50238-72) N. S. SAVANNAH. Notice of Receipt of Application for Transfer of License. (Division of Reactor Licensing (AEC), Washington, D. C.). 21 Sep 1970. 2p. Dep. CFSTI.

47926 (RAND-P-4077) NUCLEAR REACTORS ON SHIPS: A BIBLIOGRAPHY. Literature Search No. 138. Weiss, Stephanie (RAND Corp., Santa Monica, Calif.). May 1969. 47p.

References from Nuclear Science Abstracts (1961 through March 15, 1969) on nuclear reactor power plants for naval vessels, merchant ships, and submarines are presented. (H.D.R.)

47927 PHYSICAL CHARACTERISTICS OF THE SEVER MOBILE NUCLEAR POWER PLANT. Inyutin, E. I.; Matveenko, V. I.; Morozov, I. G.; Orekhov, Yu. I.; Plaksin, E. A.; Sergeev, Yu. A.; Sidorov, G. I. This paper was summarized in At. Energ. (USSR); 26: 445(May 1969) as paper No. 283. (In Russian).

The physical characteristics of two water-cooled, water-moderated reactors with consumable absorbers and active zones of the same size, 640 mm in diameter and 575 mm high, were studied. The reactors used the same fuel elements in square, 78 × 78-mm assemblies, with 49 or 64 pieces per assembly. The fuel elements were spaced at 11 or 9.5 mm in the assemblies; the ^{235}U charge was 23.6 kg or 31.6 kg. A rod with a consumable absorber (Gd or Cd) could be used to replace any of the fuel elements. In addition, the stainless-steel assembly cover could be replaced with a boron-steel cover. The experimental results were analyzed in a two-group diffusion approximation, taking account of the neutron-thermalization effects. The following quantities were calculated and found experimentally: (1) the reactivity reserve of the reactors; (2) the efficiency of the rods with consumable absorbers, with different numbers of rods and at different positions in the active zone; (3) the heat-evolution field along the assembly, and the effects of the number and positions of rods with consumable additives and of the shape of the fuel charge on the nonuniform heat evolution along the assembly; (4) the temperature effect on the reactivity with various numbers and types of consumable absorbers in the active zone. The calculated values of the physical characteristics are in good agreement with the experimental data. In some cases, however (for the temperature effect), the discrepancies reach 25%. (auth)

47928 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Deighton, Thomas (to Babcock and Wilcox Ltd.). British Patent 1,204,125. 3 Sep 1970. Filed 2 Dec 1966.

The flow of coolant upwardly through the core of a reactor exerts an upward force on fuel element assemblies, and this force must be resisted. In a marine reactor forces may act, as a result of movement of the ship, in all directions on the fuel element assemblies, and Lloyd's specification requires that shock forces of 3g in all directions should be resisted. Means are described to withstand forces acting on a fuel element assembly longitudinally of the core. The core includes a fixed member to which the lower end of the fuel element assembly is connected by latching means which serves to prevent movement of the assembly longitudinally relative to the fixed member. This latching means includes a member reciprocable in a guide between an operative position in which it co-operates with surfaces of the fuel element assembly and the fixed member to prevent longitudinal movement and an inoperative position in which it permits such movement. A control member is provided, which is movable between a position in which it holds the reciprocal member in its operative position and a position in which it releases the reciprocal member from retention in the operative position. Various arrangements of reciprocal members and control members are described. (UK)

Production Reactors

47929 (BNWL-1343) COST ANALYSIS OF IMPROVED REGULATION OF THE COLUMBIA RIVER TO INCREASE MINIMUM FLOW IN THE HANFORD PLANT VICINITY. Legan, R. W.; Jaske, R. T. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jun 1970. Contract AT(45-1)-1830. 76p. Dep. CFSTI.

The operational history of the week of October 24–31, 1967 is reviewed with respect to the actual operations of the Priest Rapids Project and the resulting effects on the flow of the Columbia River. These effects are compared with the degree of management also exerted at the McNary project during the time period. The adverse effects of the uncoordinated regulation of the Columbia River are summarized with respect to Washington State temperature standards. This uncoordinated regulation, much of which could have been reduced by special arrangements, produced a historical record of thermal modifications of continuing interest to researchers studying the effects of peaking operations on the Columbia River. The linear program code UMPIRE was used to model the actual conditions and, by superposition, minimum flow constraints ranging upwards from 36,000 ft^3/sec by 10,000 ft^3/sec increments were imposed on the Hanford reach. All scheduled power and energy demands of the Priest Rapids project and the McNary project that existed on that week were met. Where necessary to make each other whole, transmission was used between Big Eddy and the Priest Rapids project to balance requirements. The transmission system existing on February 1970 was used to make the study. The study showed that the minimum flow of the Hanford reach could be economically raised to 66,000 ft^3/sec or higher if special arrangements could be made to eliminate wheeling charges for energy exchange between Grant County and Bonneville which constituted the primary cost of minimum flow increases under study assumptions. The economics suggest that large reductions in the cost of proposed navigation channel facilities can be made by basing the channel design on 66,000 ft^3/sec or higher minimum flows in the Hanford reach. The extra cost for energy losses and management represents a small fraction of the construction cost reduction when capitalized. The study shows the great benefits to multipurpose river use from system coordination on a regional rather than a separate private-federal basis

as exists currently. More investigation of other details of the proposed arrangement is recommended. (auth)

47930 (BNWL–1344) SIMULATION OF THE EFFECTS OF HANFORD AT THE WASHINGTON–OREGON BORDER. Jaske, R. T.; Daniels, D. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Jul 1970. Contract AT(45-1)-1830. 32p. Dep. CFSTI.

A series of transects taken in the summer and fall of 1969 at the Oregon and Washington border are used as the basis for checking the accuracy of the COLHEAT simulation model and the extent of stratification and mixing which occurs in the reservoir under conditions where solar thermal input is at a maximum. The model is then used to estimate the extent to which heat additions at the Hanford Plant (Columbia River Mile 382) persist to the Washington-Oregon border (River Mile 308) under a range of statistically determined extreme and normal conditions expected after completion of the Columbia Treaty dams in 1975. The results show that 65% or more of the incremental addition to the temperature of the Columbia River between Priest Rapids dam and Richland is dissipated in the reach under study. The remaining 35% is only weakly related to the weather in terms of yearly variations. The study suggests the practicability of using computer simulation as the basis for management of stream standards using in situ stream conditions as the basis of the judgment. (auth)

47931 (BNWL–1423) A SUMMARY OF BATTELLE-NORTHWEST LABORATORY CONTRIBUTIONS TO MFC-12. Eschbach, E. A.; Reardon, W. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1970. Contract AT(45-1)-1830. 39p. Dep. CFSTI.

The major intent of MFC-12 was to conceive ways in which Hanford production reactors could be altered to increase their versatility in nuclear products and services. The two major reactor alterations considered would (1) supply extensive testing capability for fuels and other materials in both thermal and fast neutron fluxes and (2) provide special holes or regions in the reactor for irradiating a variety of targets. Potential testing services, isotope production, and production of low-shielding-type radioisotopic heat sources are described. (H.D.R.)

47932 (BNWL-CC–2659) DECONTAMINATION STUDIES FOR N REACTOR. Ayres, J. A. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). 22 May 1970. Contract AT(45-1)-1830. 31p. Dep. CFSTI.

The radioactive films that are formed in pressurized water reactors, the resulting problems, and the procedures that may be used to remove these films and decontaminate the reactor are described. The discussion is centered principally on problems relating to decontamination of reactors containing carbon steel piping. The use of neutral chelating solutions for cleaning and maintaining cleanliness in a nuclear reactor is discussed in detail. 14 references. (auth)

47933 (DUN-SA–128) IN-PLACE TEST RESULTS OF THE N-REACTOR CHARCOAL CONFINEMENT FILTERS USING IODINE TAGGED WITH ^{131}I TRACER. Mecca, J. E. (Douglas United Nuclear, Inc., Richland, Wash.); Ludwick, J. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Sep 1970. Contract AT(45-1)-1857. 28p. (CONF-700816–2). Dep. CFSTI.

From 11th AEC Air Cleaning Conference, Richland, Wash.

The implementation of in-place testing at the N Reactor is described. A description of the equipment, procedures and results obtained in testing of the charcoal filter confinement systems at the N Reactor initially and subsequently to the present time is presented. 6 references. (auth)

Reactor Theory

Refer also to abstract 47805.

47934 (ANL–7610, pp 465–537) REACTOR COMPUTATION METHODS AND THEORY. (Argonne National Lab., Ill.).

From Reactor Physics Division Annual Report, July 1, 1968–June 30, 1969.

CRITICAL ASSEMBLIES— lattice parameters of ZPR assemblies, ARC system module for heterogeneity effects in
— neutron resonance absorption in fast, RABBLE code modification for
— neutron transport calculations in fast, cross section averaging schemes for group collapsing and cell homogenization in
— neutron spectra in ZPR-6 Assembly 6C, effects on MACH-1 code central worth and criticality calculations of prompt
LIQUID METAL FAST BREEDER REACTOR— fuel cycle calculations for, solution techniques used in REBUS code for
MATHEMATICS— model development for reactor physics calculations
— integration of experimental data using Gauss-Legendre quadrature, NUMQUAD code for numerical
NEUTRON CROSS SECTIONS— calculation of average fission, in fast spectra, SIGBAR code for
— calculation of fast reactor effective multigroup, comparison of codes for
NEUTRONS— diffusion in reactors, ARC system perturbation modules for
— resonance absorption in fast critical assemblies, RABBLE code modification for
— transport calculations in fast critical assemblies, cross section averaging schemes for group collapsing and cell homogenization in
— resonance absorption of, method for calculation of J-function in
— collision probabilities in infinite slab geometry, summing exponential integral functions in calculations of
— resonance absorption in plate type lattices, integral transport methods in calculations of
— moderation in fast reactors, asymptotic slowing down equations for inelastic
— flux synthesis for reactor calculations, functionals for discontinuous trial function
— flux synthesis for reactor calculations, boundary conditions in variational
— flux synthesis for reactor calculations, solution of interface overdetermination in spatial
— flux in infinite slab reactors, weighting function choices for spatial
NEUTRONS, PROMPT— spectra in fast critical assemblies, effects on MACH-1 code central worth and criticality calculations of
REACTORS— physics calculations for, theory and methods development for
— physics calculations for, capabilities of ARC system for
— neutron diffusion in, ARC system perturbation modules for
— kinetics of infinite slab, weighting function choices for spatial
— kinetics equations for, undetermined parameters method for integration of multimode
— mathematical models of, hybrid computer simulation of large
REACTORS, FAST— neutron cross sections for, codes for calculation of effective multigroup
— neutron moderation in, asymptotic slowing down equations for inelastic
— neutron fission cross sections in, SIGBAR code for average (H.D.R.)

47935 (CONF-680980) JAPAN–UNITED STATES SEMINAR ON NUCLEAR REACTOR NOISE ANALYSIS, SEPTEMBER 2–7, 1968, TOKYO AND KYOTO. (Japan Society for the Promotion of Science. National Science Foundation, Washington, D. C.). 412p.

Included are 28 papers on theoretical and experimental techniques for analysis of neutronic and non-neutronic noise in reactors. A separate abstract was prepared for each paper. (H.D.R.)

For abstracts of individual papers see: 47821–47823, 47831, 47901, 47902, 47936, 47937, 47943–47955, and 47966–47972.

47936 (CONF-680980–, pp 379–96) ANALYSIS OF NEUTRON WAVES IN CONTINUOUS EIGENVALUE REGION. Utsuro, Masahiko (Kyoto Univ. (Japan). Research Reactor Inst.).

An analysis is presented about the neutron wave propagation in the frequency region beyond the limiting frequency for discrete eigenvalues, so that the distribution of the modulated neutrons in the medium is described by the integrals over the continuum. A further pursuit of the root of the dispersion law with making use of the analytic continuation in the angular integral gives a root on another branch neighboring to the principal one of the complex eigenvalue planes. It is shown that this root on the neighboring sheet can bring about a sharp resonance, i.e. "a pseudodiscrete wave eigenvalue," in the continuum in some cases. Application of this analysis is also shown in the case of graphite. (auth)

47937 (CONF-680980–, pp 397–412) NEUTRON WAVE PROPAGATION IN A SYSTEM OF HETEROGENEOUS PLANE LATTICE. Takahashi, A.; Sumita, K. (Osaka Univ. (Japan)).

Measurements of neutron pulse propagation were carried out in systems of heterogeneous plane lattices constructed with

graphite and hydrogenous materials (paraffin and meta-acrylite). The effective diffusion parameters, diffusion length and diffusion coefficient, for the parallel and perpendicular directions were reduced from measured squared complex relaxation lengths. An elementary method of theoretical analysis was shown following the P-1 equation with space dependent cross sections. Parallel and perpendicular dispersion relations were derived as determinants of matrices. The complex inverse relaxation lengths of experimental systems were calculated, and compared in fairly good agreement with the experimental results in the form of effective diffusion parameters. (auth)

47938 (NP-18369) TEMPERATURE DEPENDENCE OF THE STRUCTURE OF ^{238}U CROSS SECTIONS IN THE UNRESOLVED RESONANCE REGION. Van'kov, A. A.; Grigor'ev, Yu. V.; Nikolaev, M. N.; Filippov, V. V.; Bemer, B.; Kollatts, Z.; Pikel'ner, L. B. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). 1968. 18p. Dep. CFSTI (U. S. Sales Only).

In fast energetic reactors with ceramic fuel and sodium heat transfer medium, the Doppler temperature coefficient of reactivity is a main factor compensating the growth of reactivity in case of an accident in which sodium is removed from the active zone. Therefore, a reliable estimate of the nuclear safety of atomic electric power stations with this type of reactor requires that both these competing components be known with a rather high degree of accuracy. The greatest difficulty in this case is in considering the Doppler effect, since the reliability of information on the mean resonance parameters determining the Doppler effect in the area of unresolved resonances is not great. This has brought up the problem of sufficiently direct measurement of parameters determining the Doppler effect in the principal fissionable isotopes throughout the entire energy range where it appears. The first object of investigation was uranium-238, which produces approximately 20% of the full Doppler effect in fast power reactors. (auth)

47939 THERMOS TYPE METHOD FOR CALCULATING THE THERMAL NEUTRON DISTRIBUTION IN A REAL REACTOR CELL. Isbasescu, Mihai (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys.; 15: 181-206(1970).

The integral Boltzmann equation, in the P_0 approximation, is reduced to an equation which refers to a single cell from an infinite array, the interaction with the neighbouring cells being expressed by the transport matrix. The essential part of the transport matrix calculation consists in exploring the lattice along a "neutron beam." This calculation is described (Algol-code Explin) for a cylindrical rectangular reactor lattice where the cells are considered in their real square form and the isoflux lines are represented by two kinds of families of concentric circles. (auth)

47940 THERMAL CRITERIA OF THE QUALITY OF THE AXIAL ENERGY DISTRIBUTION IN A REACTOR. Filin, Yu. P. At. Energ. (USSR); 28: 500-1(Jun 1970). (In Russian).

The distribution of energy along a reactor channel can be varied by placement of the control rods, by use of an adsorber which is burned out, or by the loading arrangement. The reactor power is limited by the critical heat flux, the maximum temperature of the fuel elements, or the maximum temperature of the heat transfer agent. A channel with the maximum heat output (minimum reserve) in the reactor is selected for analysis. For a given channel construction and fuel element, it is possible to write a functional which depends on the energy distribution in the channel and on the enthalpy of the heat transfer agent. The minimum thermal reserve is ordinarily attained at a certain channel point beyond the point of maximum energy evolution (along the path of the heat transfer agent). An equation is given for obtaining the optimum energy distribution which assures a homogeneous thermal reserve along the entire length of the channel. By this equation it is possible to calculate axial energy distributions more accurately from the point of view of quality. (TTT)

47941 OPTIMUM ^{149}Sm BURNUP IN SHUTDOWN OF A HIGH-FLUX REACTOR. Zaritskaya, T. S.; Rudik, A. P. This paper was summarized in At. Energ. (USSR); 26: 448-9(May 1969) as paper No. 290. (In Russian).

"Death" of a reactor by samarium poisoning is what happens when so much ^{149}Sm forms during shutdown that the reactivity margin is inadequate to override the poison when the reactor is started up again. The problem of optimum samarium burnup during shutdown is solved. The L. S. Pontryagin maximum principle is applied to find the set of conditions minimizing the transient time. The optimum conditions are represented on the phase diagram of the concentrations of promethium and samarium. The steady state of the reactor prior to shutdown, the reactor power at zero level, the reactor performance at maximum permissible samarium concentration, the reactor power determined from the laws of classical variational calculus, the reactor performance at maximum power, and the final zero-power state of the reactor are represented. At the peak neutron flux at 3×10^{14} neutrons/$cm^2 \cdot$ sec and permissible samarium concentration three times the steady-state value, the minimum transient time is about five full days. (auth)

47942 THEORY AND ITERATIVE SOLUTION OF A MODEL FOR FISSION-PRODUCT DEPOSITION. Nelson, Paul Jr.; Kress, T. S. (Oak Ridge National Lab., Tenn.). SIAM (Soc. Ind. Appl. Math.) J. Appl. Math.; 19: 60-74(Jul 1970).

A study of an initial boundary value problem for a certain (semilinear) hyperbolic system of two partial differential equations is presented. This problem is a dimensionless form of a mathematical model which occurred in the study of fission product deposition in gas-cooled nuclear reactors. The problem is shown to have a unique solution. It is further proved that the solution satisfies physically reasonable bounds and approaches a solution of the corresponding steady state problem as $t \to \infty$. An iterative approximation scheme is shown to converge to the solution and to give alternating upper and lower bounds on the solution. Numerical results show that this iterative scheme should have practical merit for a certain parametric range. (auth)

Kinetics

Refer also to abstracts 47821, 47831, 47877, and 47901.

47943 (CONF-680980-, pp 1-9) THEORETICAL PHASES OF NEUTRON FLUCTUATION RESEARCH IN JAPAN. Otsuka, Masuhiko (Electric Power Development Co. Ltd., Tokyo (Japan)).

A brief summary of the theoretical research of neutron fluctuations in reactors, developed in Japan, is presented. It seems that, as far as zero-power reactors are concerned, the fundamental structure of the stochastic processes in neutron fields has been well understood and its mathematical formulation has been established. Main efforts are now turned to the study of power reactor noise. (auth)

47944 (CONF-680980-, pp 11-24) THEORETICAL STUDY OF AT-POWER REACTOR NOISE. Saito, Keiichi; Taji, Yukichi (Japan Atomic Energy Research Inst., Tokai).

A new formulation of the noise in at-power reactors is developed. The result is applied to a point reactor with single loop and two loops of reactivity feedback. Input noise source is so determined that ready comparison is possible between the noise spectra and the square modulus of the reactor transfer function. Physical meanings of the noise source are clarified. The presupposition underlying the present theory is that a set of macrostochastic variables characterizing the state of a reactor is possessed with the Markoffian properties. Three types of elementary reactions are taken into account; the source emission, the linear, and the bilinear reaction. (auth)

47945 (CONF-680980-, pp 25-33) GAMMA-RAY FLUCTUATION MEASUREMENTS VERSUS NEUTRON FLUCTUATION MEASUREMENTS. Osborn, Richard K. (Michigan Univ., Ann Arbor).

Some of the potentially practical and unique aspects of the gamma ray fluctuation spectrum measurement technique for determining dynamic reactor parameters are discussed. It is concluded that gamma ray fluctuation measurements may have some advantages over neutron counting with respect to fast reactors. (H.D.R.)

47946 (CONF-680980-, pp 35-50) BASIC STUDIES ON THE ROSSI-ALPHA EXPERIMENT. Iijima, T. (Japan Atomic Energy Research Inst., Tokai).

The results of the theoretical and experimental studies on the correlation amplitude in the Rossi-α experiment which does not follow the conventional Rossi-α theory (Orndoff's theory) in the usual measurement are given. It is shown that the correlation amplitude depends on the condition of the trigger count, and Orndoff's amplitude is the average of those triggered by all pulses from the detector. The experimental results proving this theory are presented. A new method is proposed for obtaining the correlation amplitude by measuring the distribution of the number of family counts. (auth)

47947 (CONF-680980-, pp 51-70) ERROR ANALYSIS OF NUCLEAR NOISE MEASUREMENTS. Bendat, J. S. (Measurement Analysis Corp., Los Angeles, Calif.).

Various fundamental ideas and techniques for analyzing nuclear noise measurements and their errors are discussed. Current results on fast Fourier transform procedures are covered, as well as material on digital computer programs to carry out noise measurements. (auth)

47948 (CONF-680980–, pp 161-73) CORRELATOR WITH REAL TIME OPERATION. Nishino, Osamu; Hasegawa, Ken-ichi; Ando, Takeshi (Tokyo Univ. (Japan). Dept. of Nuclear Engineering).

In order to simplify the time shifter of the correlator, a new calculation method of correlation function has been developed in which sampling frequencies for input signals are different; one is higher and the other is negligibly lower than twice the highest frequency component of the input signals. In the correlator presented, a very simple time shifter is adopted and address and/or readout circuits are successfully removed by using a dynamic memory system and selecting the prime number for the total channel number of the correlator. The correlator was applied to fluid velocity measurement in the experimental water loop. For the fully developed turbulent flow, the fluid velocity was measured within the error of ±2.5% by the transit time method using thermocouple pairs as sensors. (auth)

47949 (CONF-680980–, pp 175–83) FLUCTUATION SIMULATOR OF THE REACTOR NEUTRONS USING THE PULSED NEUTRON SOURCE AND ITS APPLICATIONS. Yasuda, H.; Nakamoto, K.; Sumita, K. (Osaka Univ. (Japan)).

The fission phenomena in a multiplying medium are simulated by the neutron bursts of the pulsed neutron source in a non-multiplying medium. To simulate the chain reaction, the pulsed neutron source is triggered by the neutronic signals from the detector installed in that medium. The variety of the kinetic parameters can be obtained through the choices of the detector sensitivity, the system medium, and the burst yield of the pulsed neutron source. This principle is applied to the simulations of Rossi-α experiment, pulse die away experiment, Feynman-α experiment and waiting time distribution experiment. The results show that, in principle, this simulator can represent the probabilistic nature of the neutrons in a multiplying medium. The applicable range is limited so far within $k = 0$ to 0.66 by the characteristics of the pulsed neutron source used. (auth)

47950 (CONF-680980–, pp 185-96) NOISE IN POWER REACTORS: A REVIEW OF EXPERIMENT, ANALYSIS, AND THEORY. Thie, Joseph A.

Power reactor noise experiments are reviewed with their complexities in comparison to zero reactor experiments noted. An effort is made to have broad inclusive coverage of the types of experiments, approaches of analysis, and categories of results. There are tabulations of experimental techniques, variety of accomplishments, and the relative advantages of methods in use – thus making possible critical evaluations based on experience. Fundamental sources of noise and their theoretical basis are discussed. Though there have been many qualitatively successful explanations, there are quantitative weaknesses. Types of experiments which would be fruitful are suggested. 36 references. (auth)

47951 (CONF-680980–, pp 197-210) NOISE ANALYSIS OF BOILING WATER REACTOR. Nomura, Tsutomu (Nippon Atomic Industry Group Co. Ltd., Tokyo).

Neutron fluctuation tends to be somewhat larger in boiling water reactors compared with other reactors. Most of the fluctuation is considered attributed to boiling noise particular to the BWR. The behavior of the void generated at steady heat output is analyzed with equations of two phase flow. A time series obtained from random void generation along a boiling channel causes fluctuations in direct void fraction, flow, pressure and temperature, as well as in neutron flux. The mechanisms of interrelationship between these factors of fluctuation are physically explained and a calculation has been made of the power spectral density of neutron fluctuation. It is concluded that the predominant noise source in the BWR is steam generation and the associated fluctuation due to the discrete nature of the steam bubbles discharging into the steam space. (auth)

47952 (CONF-680980–, pp 211-25) NEUTRON FLUCTUATIONS AT FULL POWER. Sheff, James R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The theory of neutron fluctuations in a nuclear reactor operating with feedback effects is developed. The principal method used was the Langevin approach which was extended to allow iterative solutions of the nonlinear feedback equations. The theory was applied to one and two feedback coefficient models, and calculated results are shown for the first order solutions which result from a particularly desirable linearization of the equations. It is shown that to first order the feedback spectra can be written as being proportional to the modulus squared of the feedback transfer function plus corrections. As a direct result of the insight provided via the Langevin approach, a particular linearized solution to the probability balance set of equations was also obtained again verifying the transfer function modulus squared concept as at least a first order approximation. (auth)

47953 (CONF-680980–, pp 249-66) DETERMINISTIC SIGNALS FOR FREQUENCY RESPONSE MEASUREMENTS IN REACTOR SYSTEMS. Kerlin, Thomas W. (Tennessee Univ., Knoxville).

A number of testing and analysis procedures may be used for frequency response measurements in reactor systems, but considerations of efficiency and economy dictate that the selected procedures should be matched to the system requirements and capabilities. Pertinent theoretical characteristics and practical experiences in using and analyzing these tests are presented. (auth)

47954 (CONF-680980–, pp 307-20) ANALYSIS OF SPACE-DEPENDENT REACTOR KINETICS BY MODIFIED HELMHOLTZ MODAL EXPANSION METHOD. Wakabayashi, J.; Yoshikawa, H.; Hoshino, T. (Kyoto Univ. (Japan). Engineering Research Inst.).

Nonlinear space-dependent reactor dynamics due to reactivity accidents are studied analytically by the modified Helmholtz modal expansion method. This method has the following merits: (1) the convergence of the solution is much improved than that of the conventional Helmholtz modal expansion; (2) the comparison with the one-point kinetic model is easily made; and (3) the procedure of the calculation is very simple in case of the power excursion analysis. For the purpose of this analysis a calculation code named SPEX-1 was developed and as a sample problem the self-shutdown behaviour of power excursion due to Doppler feedback was calculated. (auth)

47955 (CONF-680980–, pp 351-61) STABILITY ANALYSIS OF LARGE BOILING WATER REACTOR BY A COUPLED REACTOR MODEL. Kawai, T. (Hitachi Ltd., Kawasaki (Japan). Nuclear Energy Div.); Sato, K.; Miida, J. (Japan Atomic Energy Research Inst., Tokai).

Stabilities of large boiling water reactors are analysed by means of a coupled reactor model. As the core dimensions in boiling water reactor increase, nuclear coupling of a region with another located far from it becomes weak, and a possibility of spacial instability might come out. A coupled reactor model is proposed which gives an insight into the physical interpretation of roles of important parameters in the spacial stability of large boiling water reactors. The proposed model is that the reactor is divided into two equivalent regions which are treated as a part of a coupled reactor with each other. Stability criteria are given based on the proposed model and the significance of the space dependency is considered. It is pointed out that the reactor can be unstable even if it is nuclear and hydraulically stable separately. (auth)

47956 (LA–4461) SYNTHESIS METHODS AND VARIATIONAL METHODS IN NUCLEAR REACTOR THEORY, PHYSICS, AND COMPUTATIONAL METHODS: A BIBLIOGRAPHY. Furnish, Jean (comp.) (Los Alamos Scientific Lab., N. Mex.). Aug 1970. Contract W-7405-eng-36. 48p. Dep. CFSTI.

A search of Nuclear Science Abstracts, v. 16 (1962)–v. 23 (1969) was made for information on synthesis and variational methods in nuclear reactor theory and physics, and the computational methods involved. Abstracts are reproduced from Nuclear Science Abstracts with those from the most recent volume given first. Within each volume the arrangement is numerical. A rough delineation of subjects has been indicated as follows: neutron transport theory; static group diffusion theory; reactor kinetics; reactor burnup and fuel cycle analysis; reactor space-energy synthesis; reactors–general; reactor multi-dimensional space synthesis; and reactor shielding. Entries not so marked are for miscellaneous material. An index of personal authors appears at the end of the compilation. (auth)

47957 (NP–18367) INTEGRAL METHODS OF ABSOLUTE MEASUREMENTS OF CERTAIN CHARACTERISTICS OF NUCLEAR REACTORS. Mogil'ner, A. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Obninsk. Fiziko-Energeticheskii Institut). Apr 1967. 11p. Dep. CFSTI (U. S. Sales Only).

It has been demonstrated that certain integral relationships for the statistical weights of the components of materials occur in a critical reactor. The corresponding theorem is extended to an

arbitrary reactor, the properties of the constant K^+ are calculated, and certain experimental applications are noted. (auth)

47958 (RT/FI–(70)5) ANALYSES OF THE CALCULATION METHOD FOR CONTROL RODS: COMPARISON WITH ROSSI ALPHA MEASUREMENTS. Fiorentino, S.; Michelini, M.; Torelli, L. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 15 Dec 1969. 75p. (In Italian). Dep. CFSTI (U. S. Sales Only).

The most advanced method of calculation for control rods is the P_1 Blackness Theory. The accuracy of the method is evaluated, both from the purely spatial effect standpoint (by comparing with DP3 transport calculations) and from the general (spatial + energetic) standpoint by comparing with Rossi-alpha measurements. (auth)

47959 (RT/FI–(70)21) CELL CALCULATIONS FOR REACTOR FUEL CONTAINING Gd AS A BURNABLE POISON. Caldognetto, U.; Pistella, F. (Comitato Nazionale per l'Energia Nucleare, Rome (Italy)). 29 Apr 1970. 53p. Dep. CFSTI (U. S. Sales Only).

The cell constants are calculated for a set of reference reactor cells containing burnable poisons by simplified as well as sophisticated models. Calculations of flux distributions are performed to evaluate to what extent the deviations appearing among the results of the different models affect the power distribution. In addition it is shown that enough information is available on the absorption rate of Gd in the poisoned pins when the activation rates of few standard detectors are known. 16 references. (auth)

47960 (WAPD-TM-960) NOTES ON NUCLEAR REACTOR KINETICS. Yasinsky, J. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). Jul 1970. Contract AT-11-1-GEN-14. 144p. Dep. CFSTI.

A survey of the field of nuclear reactor kinetics is presented with emphasis on the problem of describing the neutron distribution in nonsteady-state reactors. Group-diffusion theory is used as a basic model to develop the general reactor kinetics equations. Specific topics include interpretation of the adjoint flux and its mathematical utility, space-independent kinetics, the point kinetics equations, perturbation theory, the inhour equation, interpretation of experiments, temperature feedback, and stability. Topics concerning space-dependent kinetics are approximation methods such as finite differences, adiabatic, nodal, modal and synthesis techniques; fission product poisoning and xenon spatial stability. (auth)

47961 IMPLICIT METHOD FOR SOLVING THE LUMPED PARAMETER REACTOR-KINETICS EQUATIONS BY REPEATED EXTRAPOLATION. Izumi, Masayuki; Noda, Takashi (Hitachi Ltd., Kawasaki, Japan). Nucl. Sci. Eng.; 41: 299-303(Aug 1970).

The implicit method and repeated extrapolation are combined to give a stable and accurate method of numerical analysis of a set of ordinary differential equations. This method is successfully applied to reactor kinetics equations which usually suffer from nonphysical numerical instability arising from short neutron lifetimes. (auth)

47962 INTERFACE CONDITIONS FOR DISCONTINUOUS FLUX SYNTHESIS METHODS. Terney, William B. (Knolls Atomic Power Lab., Schenectady, N. Y.). Nucl. Sci. Eng.; 41: 303-7(Aug 1970).

The use of spatially discontinuous flux synthesis methods for the static and transient analyses of complex reactors is discussed. It is shown that the same results are obtained from both the standard variational and direct integration approaches even when both the current and flux expansions are discontinuous at the same interface. These results are extended to the case where there are different numbers of trial functions on either side of an interface. (H.D.R.)

47963 FIZIKA YADERNYKH REAKTOROV. VYPUSK 2. (Nuclear Reactor Physics. Number 2). Moscow; Atomizdat (1970). 192p.

Sixteen articles are included on reactor physics considering effective synthetic methods for designing nuclear reactors, mathematical calculations, analytical estimation of diffusion characteristics, nuclear physical parameters and reactor dynamics. Optimization of fast nuclear reactors, critical problems in multizone cylindrical reactors, the threshold cross sections considering the thermal nuclear motion, neutron passage through substance and the multigroup problem of neutron transport, are discussed as well as stabilization of heat release field in fast power reactors operating with mixed fuel cycle, efficiency of eccentrically distributed absorbers in uranium-water critical assembly, and source of thermal neutrons with assigned spatial distribution in the IRT-reactor. (R.V.J.)

47964 LIMITING RATIO OF MAXIMUM THERMAL-NEUTRON FLUX TO REACTOR POWER. Kochenov, A. S. This paper was summarized in At. Energ. (USSR); 26: 449-50(May 1969) as paper No. 292. (In Russian).

An important parameter in the study of a reactor, along with the absolute value of the maximum thermal-neutron flux, is the ratio of the maximum thermal-neutron flux to the reactor power (Φ_{max}/N). For a homogeneous active zone, the ratio of the average thermal-neutron flux to the reactor power is inversely proportional to the ^{235}U charge. The minimum critical ^{235}U charge is attained in reactors with heavy-water moderators and reflectors (297 g) and in reactors with ordinary-water moderators and beryllium reflectors. In these reactors, we have $\Phi_{max}/N \approx 10''$ neutrons/cm^2 · sec · kW. The values of Φ_{max}/N and k_∞ required for criticality in water-cooled, water-moderated reactors with ordinary-water traps and beryllium reflectors are tabulated. With a trap radius of 5 cm and $k_\infty \approx 1.8$ (which can be attained with any fissionable isotope), the ratio Φ_{max}/N turns out to be three times as high ($\sim 3 \times 10^{11}$ neutrons/cm^2 · sec · kW) as for a homogeneous active zone. In the best contemporary reactors (SM-2 and HFJR) the ratio is $\Phi_{max}/N \approx 5 \times 10^{10}$ neutrons/cm^2 · sec · kw, i.e., about six times lower than the estimate obtained. (auth)

Dynamics

47965 DYNAMICS FOR PROCESS AND SYSTEM CONTROL. Yang, Wen-jei; Masubuchi, Masami. New York; Gordon and Breach, Science Publishers, Inc. (1970). 453p. $29.50.

Analytical methods and experimental techniques for the determination of process and plant dynamics are investigated, with major emphasis on typical industrial processes and plants. Included are discussions of: transport processes and control; analytical methods for dynamic analysis; the dynamics of lumped-parameter systems, distributed parameter systems, nonlinear systems, and time-varying systems; the measurement of dynamic response; plant dynamics; and the relationship between dynamic analysis and control systems. (H.D.R.)

Experimental Applications

Refer also to abstract 47818.

47966 (CONF-680980–, pp 103-22) LOCAL IN-CORE POWER MEASUREMENTS WITH OUT-OF-CORE GAMMA DETECTORS. Kenney, E. S.; Schultz, M. A. (Pennsylvania State Univ., University Park).

Measurements have been made of local power level at various spots inside a reactor core using collimated gamma ray beams. The measurements were essentially of reactivity induced noise and were made with a conventional two-input electronic correlator. The results indicated that a plot of power distribution through a reactor could be obtained to a core depth of approximately 10 cm with simple detecting apparatus mounted external to the core. The plot obtained with the correlated gamma rays closely resembled one obtained by a conventional cobalt wire neutron activation. (auth)

47967 (CONF-680980–, pp 123-40) ESTIMATE OF SUBCRITICALITY BY OPTIMAL FILTERING METHOD. Suda, Nobuhide; Shirai, Shoji (Osaka Univ. (Japan)).

Measurements of the reactor parameters, such as prompt neutron generation time, subcriticality and so on, have been made using a band pass filter or the correlation technique. New methods of reactor parameter estimates are now available, such as optimal linear (Kalman) filter and some of the nonlinear optimal filters, and in the parameter estimation technique, such as the stochastic approximation, and the linear and nonlinear regression. These new methods are very promising for the on-line estimate of the reactor parameters. The application of some of these new methods to the subcriticality measurement is described. There are presented the results of computer simulation of estimates using the Kalman filter, stochastic approximation and so on. Experiments are also made with the actual reactor noise of Toshiba Training Reactor (TTR-1) and using a nonlinear analog filter. The results agreed with those obtained by conventional methods. (auth)

47968 (CONF-680980–, pp 141-60) REACTOR-NOISE STUDIES WITH AN ON-LINE DIGITAL COMPUTER. Cohn, Charles Erwin (Argonne National Lab., Ill.).

A method is described for using a DPP-24 digital computer to analyze noise from a fast critical assembly and to determine the prompt-chain decay constants. The method, which uses polarity

correlation, was used to measure the Rossi-alpha in a fast assembly at a power level of 5W. The polarity correlation algorithm developed for this application was also adapted for use in a study of the dynamics of a digital control scheme. (H.D.R.)

47969 (CONF-680980–, pp 227-32) REACTOR NOISE BEHAVIOR AT POWER OPERATION. Yamada, S.; Kage, H. (Hitachi Ltd., Kawasaki (Japan). Nuclear Energy Div.); Hoshi, T. (Japan Atomic Energy Research Inst., Tokyo).

Two types of noise analysis are investigated to make clear the sources of reactor noise excitations. The first is a noise source excited by coolant flow fluctuations in Hitachi Training Reactor (HTR), and the second is excited by void fluctuations in Argonaut reactor with bubble streams and Japan Power Demonstration Reactor (JPDR) with boiling. In HTR experiments, the comparison between power spectra of neutron flux fluctuation and coolant-flow rate fluctuation, made clear that the same resonances are caused by coolant-flow fluctuations that excite vibration of control rods. In JPDR experiments, noise spectra of neutron flux, void change, pressure, and flow were measured. Each noise power spectrum showed nearly the same characteristics as the results of Argonaut experiments. Space dependency was found in power spectra of several incore monitor signals. (auth)

47970 (CONF-680980–, pp 285-306) COHERENCE FUNCTION: A MEASURE OF SPATIALLY DEPENDENT NUCLEAR REACTOR PROPERTIES. Albrecht, Robert W. (Washington Univ., Seattle. Dept. of Nuclear Engineering); Seifritz, Walter (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Neutronenphysik und Reaktortechnik).

The stochastic coherence function is introduced and its properties are analyzed in the case of a two node coupled reactor system. If the fundamental mode is dominant, the coherence function is unity for all frequencies. Departures from unity are related mathematically to space dependent phenomena. The case of the two node system displays all of the essential properties of the coherence function while retaining a simplicity which allows relatively straightforward physical interpretation. Experimental determinations of the coherence function in the Argonaut Reactor (Kernforschungszentrum Karlsruhe) with both a ring core loading and a two slab core loading are reported. The parameters of the mathematical model are found from these measurements to be in reasonable agreement with calculations as well as with an independent measurement made by rod drop methods. In addition, it is found that the mean time delay is insensensitive to the form of the time delay density function. The value of the mean time delay is shorter than that predicted by thermal neutron wave theory and much shorter than the time delay for a typical Argonaut Reactor quoted in the literature. (auth)

47971 (CONF-680980–, pp 321-35) PILE-OSCILLATOR MEASUREMENT AND THEORETICAL STUDY OF SPACE-DEPENDENT TRANSFER FUNCTION OF A REFLECTED ASSEMBLY. Hoshino, T.; Yoshikawa, H.; Wakabayashi, J. (Kyoto Univ. (Japan). Engineering Research Inst.).

A pile-oscillator was inserted in the center of the core of a spherically symmetric reflected core assembly. Output pulses from the counters placed at several points were lead to a multichannel time analyzer. The transfer function was obtained by Fourier analysis of the time analyzer output. Space-dependence of the transfer function was clearly observed. Several kinds of errors, such as the statistical error in neutron counting, the frequency fluctuation, and frequency measurement errors were estimated. The theoretical study of the thermal neutron wave propagation gave a good agreement with the measured results. (auth)

47972 (CONF-680980–, pp 363-77) SOME INVESTIGATIONS ON WAVE PROPAGATION EXPERIMENTS IN GRAPHITE SYSTEMS. Sumita, Kenji; Takahashi, Akito (Osaka Univ. (Japan)).

Pulse propagation experiments were carried out in pure graphite systems with various transverse dimensions (50 × 30 cm to 130 × 130 cm). Peak and valley phenomena in gain and phase curves were observed for every case. The experiment was repeated in borated graphite (about 100 ppm natural boron contained, 90 × 90 cm) system. Peaks and valleys were observed at the same frequencies. These phenomena are proof of the interference between the energetic pseudo-discrete mode and the continuous mode under Bragg cut off energy. However, the confirmation of the existence of discrete modes depending on frequency was carried out by theoretical analysis rather than by experiments. The value of the diffusion cooling coefficient was determined as $(2.8 \pm 0.5) \times 10^3$ cm^4/sec. Pulse propagation experiments were carried out in a highly subcritical natural-uranium-graphite system and in a slightly subcritical enriched uranium (20%)-graphite system, to have an insight into the difficulties of the propagation experiment in multiplying media. In the former system, the dispersion law was measured. It became possible to determine more precisely not only the material buckling, but also to obtain the newly measurable value ξ, which can't be obtained by the usual exponential experiment. The low frequency characteristics of ξ curve are strongly dependent on delayed neutrons and reactivity. The experiments in the latter system gave the trial measurement of such effect in the lower frequency region, the effect of delayed neutrons under 1 rad/s was observed clearly in the source transfer function. (auth)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 46410, 46448, 46537, 46693, 46694, 46698, 46700–46704, 46708, 46720, 46721, 46758, 46765–46768, 46773, 46775, 46783, 46785, 46812, and 46816.

47973 (ZJE–61) CALCULATION OF BOLTED JOINTS OF LARGE DIMENSIONS. Kuchta, J. (SKODA Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). 1970. 93p. Dep. CFSTI (U. S. Sales Only).

Design aspects of nuclear reactor vessel main flanges and the numerical solution of associated problems are examined. Design of such flanges must be usually treated as an individual case for each reactor because the operating requirements are complicated and, in certain respects, unique to each vessel. To facilitate the design, a general method of calculation of the flanged joint with studs is derived and shaped into a program for a digital computer. The aim is to quickly evaluate the different design projects from the viewpoint of strength and to find out the effect of structural changes or changes of operating conditions. As an example the calculation of one reactor vessel is presented. (auth)

47974 NUCLEAR REACTOR SHUTDOWN SYSTEM. (to Canadian General Electric Co. Ltd.). British Patent 1,200,951. 5 Aug 1970. Priority date 25 Mar 1967, Canada.

REACTOR CONTROL SYSTEMS—design with moderator dumping system connected to primary cooling circuit
REACTORS, HEAVY WATER MODERATED—shutdown system for, with moderator dumping actuator connected to primary cooling circuit, (H.D.R.)

47975 NUCLEAR REACTOR. Roche, Roland; Vrillon, Bernard (to Commissariat a l'Energie Atomique). British Patent 1,201,046. 5 Aug 1970. Priority date 22 Nov 1966, France.

REACTORS—shielding for pressure-tube type, design of zone
SHIELDING—design for pressure-tube type reactors (H.D.R.)

47976 NUCLEAR REACTOR COOLED BY A LIQUIFIABLE FLUID. Costes, Didier; Roche, Roland (to Commissariat a l'Energie Atomique). British Patent 1,199,513. 22 Jul 1970. Priority date 12 Apr 1967, France.

PRESSURE VESSELS—thermal insulation for reactor prestressed concrete, use of gas filled chamber for
REACTORS—pressure vessels for, design of thermal insulation for prestressed concrete
THERMAL INSULATION—design of gas filled chamber for prestressed concrete reactor pressure vessel (H.D.R.)

47977 THERMAL SHIELD FOR HEATING ENCLOSURE. (to Societa pour l'Industrie Atomique). British Patent 1,199,639. 22 Jul 1970. Priority date 23 Dec 1966, France.

PRESSURE VESSELS—thermal insulation for reactor prestressed concrete, design of fluid cooled porous fabric
REACTORS—pressure vessels for, design of thermal insulation for prestressed concrete
THERMAL INSULATION—design of fluid cooled porous fabrics for prestressed concrete reactor pressure vessel (H.D.R.)

47978 NUCLEAR REACTOR SERVICING INSTALLATIONS. Jones, Graham Henry; Ealing, Christopher John; Burton, John Cornelius (to English Electric Co. Ltd.). British Patent 1,202,401. 19 Aug 1970. Filed 28 Jul 1967.

Reference is made to installations for the remote handling of fuel assemblies and control rod assemblies. The installation described comprises an enclosed radiation shielded transfer chamber that communicates with the open top ends of a number of vertical tubes or ducts, which include a support tube adapted to hold the assembly whilst operations are carried out in this tube. At least one disposal duct is also provided for removal of assembly com-

ponents, together with an access duct for introducing components to the transfer chamber. A hoist unit is provided within the transfer chamber, which is movable between a number of positions over the various tubes or ducts for raising or lowering components. A second access duct is provided, through the roof of the transfer chamber directly over the support tube, to allow assemblies to be introduced from outside the installation into the support tube or to be removed therefrom. Means may be provided for passing a coolant fluid through the support tube and transfer chamber. An elevator arrangement may be provided in the support tube; also cutting means, and crushing means in one of the disposal ducts for crushing graphite fuel sleeves. One of the disposal ducts may communicate with a pond or dry storage means. (UK)

47979 NUCLEAR FUEL ELEMENT CLUSTERS. Ince, George (to United Kingdom Atomic Energy Authority). British Patent 1,202,318. 12 Aug 1970. Filed 24 May 1968.

Reference is made to cluster type fuel elements wherein the fuel pins are sheathed in a brittle ceramic material. The fuel element described comprises fuel pins having radially outwardly extending end flanges and arranged in pairs held in end-to end abutment by clamping means which engage the flanges. The design is stated to be particularly suitable for fuel pins comprising ceramic fuel sheathed in SiC, this sheath being provided with end closures which provide flanges outstanding from the sheaths. With superposed fuel pins adjacent flanges are held by shallow C-clips of SiC disposed at intervals about the flange so that a pair of fuel pins firmly abut in end-to-end relationship. The clamping means may be retained within a cluster support grid mounted in a structural sleeve, and a grid may be provided for lateral location of the ends of the pins remote from the abutting ends, this grid also being mounted in the sleeve. (UK)

47980 A DEVICE FOR SLOWING DOWN A FREELY UNWINDING CABLE. (to Groupment Atomique Alsacienne Atlantique). British Patent 1,203,803. 3 Sep 1970. Priority date 3 Nov 1966, France.

BRAKES—design of control element drive cable
REACTOR CONTROL ELEMENTS—drives for, braking device for winch cables in (H.D.R.)

47981 NUCLEAR REACTORS. Long, Everett; Rawson, Peter John (to English Electric Co. Ltd.). British Patent 1,203,220. 26 Aug 1970. Filed 9 Dec 1966.

Reference is made to reactor access arrangements comprising a standpipe consisting of an inner tube concentric within an outer tube, thus defining an annular space there between; a number of bars are arranged within this annular space so as to form a composite load bearing structure with the tubes. The bars may be arranged so as to afford a path for a cooling fluid, and various designs of coolant inlet and outlet means are described. A metallic sleeve, substantially thinner than the inner tube may be provided within the inner tube so as to reduce transverse heat flow, and may be arranged so as to allow axial movement in the inner tube in response to thermal expansion or contraction. The lower end of the standpipe may be fixed to an extension, that extends towards the reactor core, by means of a joining sleeve and arranged to act as a tensile load bearing member. A removeable plug is provided for the standpipe, having a circumferential convection inhibiting ring. (UK)

47982 AN ANNULAR SELF-LOCKING WEDGE RING SUPPORT ASSEMBLY. (to Atomic Energy of Canada Ltd.). British Patent 1,203,183. 26 Aug 1970. Priority date 3 Jun 1968, United States.

REACTORS—core tube spacers in, annular self-locking wedge ring support assembly for (H.D.R.)

47983 TECHNIQUES FOR IN-PILE MEASUREMENTS OF FISSION-GAS RELEASE. Doi, Akira; Inoue, Kiyoshi; Hayashi, Hiroshi; Ohsawa, Yasuo (Hitachi Ltd., Kawasaki, Japan). J. Nucl. Sci. Technol. (Tokyo); 7: 387-93(Aug 1970).

The continuous release of fission-gas from ceramic fuel was measured during irradiation in the Hitachi Training Reactor. Two different types of in-core assemblies were devised. In these assemblies, UO_2 specimens were heated up to 2,000°C by a heater rod of tungsten. In these assemblies, the fission gases are purged by continuously flowing Ar or He, and led out of the reactor, where the radioactivity was measured with γ-ray spectrometer. The radioactivity of Ar and fission-gas was left to decay in a radioactivity decay tank and a fission product collection train submerged in the reactor pool. (auth)

47984 METHOD OF DETECTING THE ONSET OF SUBCOOLED BOILING BY MEANS OF A VIBRATION TRANSDUCER. Kuetuekcueoglu, A.; Varadi, G. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Neue Tech., B; 11: 82-6(1969).

Preliminary measurements in the heavy-water cooled research reactor DIORIT indicated that the onset of subcooled boiling, in a throttled channel, could be detected by means of a vibration transducer mounted on the outer extension of the fuel rod. To verify this, measurements were carried out in an electrically heated out-of-pile boiling loop. At the onset of subcooled boiling, which was characterized by a rapid increase of heat transfer coefficients, a remarkable increase in the amplitudes of high frequency vibrations (2000... 11000 Hz) was observed, followed by a reduction to a lower level, near saturation. It is considered that the increase was caused by the resonance of the structure, induced by forces acting during the condensation of the bubbles close to the heated wall. The reduction of the amplitudes, near saturation, might be explained by the extra damping due to the larger gas and steam bubbles in the flow. (auth)

47985 ELECTRICALLY SIMULATED FUEL ELEMENTS WITH THERMAL INSTRUMENTATION. Engler, Ch. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen, Switzerland). Neue Tech., B; 11: 87-91(1969). (In German).

The use of indirect resistance-heated rods as substitutes for fuel rods is examined. Some of the most important design problems are discussed. An example is given to show where the major construction problems for such rods lie and how they may be solved. (auth)

47986 APPLICATION OF RELIABILITY MARGIN ANALYSIS TO FUEL ELEMENT PERFORMANCE. Sayles, C. W. (Atomics International, Canoga Park, Calif.). Nucl. Appl. Technol.; 9: 694-9(Nov 1970).

A method is presented for the fuel element designer to relate the reliability required of the fuel element to its design. Random and systematic uncertainties are used to determine the fraction of fuel rods that can exceed some limit and to determine the probability that fractions exceeding the limit is less than that allowed. The method is used with analytical models of fuel and cladding behavior. The method requires that the designer not only know the values for the variables in his analytical model, he must also know the uncertainties in these variables. When using this technique, the fuel element designer can see which of the various uncertainties are contributing the most to the uncertainty in the margin. Those uncertainties that contribute the most are those that merit additional expenditure for research and development or additional quality control effort. (auth)

47987 ANALYSIS OF CONTROL SYSTEMS INCLUDING DIGITAL METERS OF THE NUCLEAR RADIATION. Cierpisz, Stanislaw. Arch. Automat. Telemech.; 14: 429-38(1969). (In Polish).

A method of the analysis of a control system including a digital meter of the nuclear radiation is presented. The method is based on a simplified block diagram of the system under consideration. The simplification is based on the assumption that statistical properties of the measuring signal which result from the very statistical nature of the radiation intensity measurement are independent of the measured quantity. The analysis of the simplified block diagram can be performed applying the conventional theory of linear control systems. Given a structure of the system, the optimization of its parameters has been carried out with respect to the mean-square error criterion. (auth)

47988 GRABS FOR NUCLEAR REACTOR FUEL ELEMENT CLUSTERS. Saunder, Alan Charles Anthony (to United Kingdom Atomic Energy Authority). British Patent 1,200,060. 29 Jul 1970. Filed 6 Mar 1967.

The type of grab described comprises a rod located within a tube having a longitudinally extending flute and a transverse slot that intersects the flute. The rod has a transverse fin which extends radially into the slot and is rotatable in the tube from a position of the grab wherein the flute is continuous to a position wherein the flute is divided by the fin. The grab may be used for lifting fuel assemblies having a bore into which it can pass, the bore having a radially inward projection which can pass along the flute when the grab is in the first position, and being capable of supporting the assembly on the fin when the grab is in the second position. The tube may have three equi-angularly spaced flutes and a set of three transverse slots on a common plane, with three complementary fins on the rod. For use in lifting a stock of fuel element assemblies the grab may have sets of slots and fins disposed at longitudinally spaced intervals, with the intervals between sets of slots and fins greater than the intervals between projections in a stack of assemblies. The fins each have a face that is inclined relative to the longitudinal axis of the rod and disposed

so that, when used as an axial load bearing face, a sideways force is created to urge the grab into the second position. (UK)

47989 ASSEMBLY OF FUEL ELEMENTS FOR NUCLEAR REACTORS. Charrault, Jean Claude; Lafontaine, Francois; Orlowski, Serge (to EURATOM). U. S. Patent 3,520,776. 14 Jul 1970. Priority date 3 Oct 1963, Belgium.

Instead of having a plurality of fuel pencils or rods enclosed within a single pressure tube, each pencil or rod is enclosed within its own pressure tube. The assembly is thereafter mounted within a calandria. The rods are preferably sheathed with a low absorption metal formed with small heat-exchange fins. A heat-carrying fluid flows inside each pressure tube and around the rod. A thermal insulating gas is contained inside the calandria. The calandria is immersed in a moderator. In a preferred embodiment, each rod is hollowed out and sheathed internally with a low absorbing metal having fins. A heat-carrying fluid flows inside the hole of the rod. (AEC)

47990 NUCLEAR REACTORS. Orszak, Peter (to English Electric Co. Ltd.). British Patent 1,198,001. 8 Jul 1970. Filed 24 Jan 1967.

Reference is made to reactors having one or more elongated connecting assemblies within the reactor vessel which connect two structures between which, during reactor operation, substantial relative movement is liable to occur, such as to tend to cause corresponding relative movement between the ends of the connecting assemblies. In the system described the connecting assembly comprises a member arranged for rolling contact in one plane with two further members arranged for rolling contact in a plane at right angles with surfaces fixed relative to the structures. Alternatively, each connecting assembly may include a member having two end faces formed as diametrically, opposite portions of a cylinder of revolution arranged between second and third members each having a flat inner end face in rolling contact with the corresponding end face of the first member and an outer end face in rolling contact with a flat face fixed relative to the structure. The outer end faces are formed as diametrically opposed portions of a second cylinder of revolution the axis of which is perpendicular to that of the first cylinder. Various applications are described. (UK)

47991 IMPROVEMENTS IN OR RELATING TO CERAMIC NUCLEAR FUEL MATERIALS. Denton, Ivor Edison (to United Kingdom Atomic Energy Authority). British Patent 1,198,051. 8 Jul 1970. Filed 21 Jun 1966.

Reference is made primarily to the manufacture of dispersed fuels of the oxide type, and it is claimed that the process described provides an improved dispersed ceramic fuel material. The process comprises coating particles of the fuel material with BeO_2, forming an unsintered can of BeO_2, loading the coated particles into the can, filling the interstices between the particles with BeO_2, and also forming end closures of the same material. The BeO_2 is then sintered, whereby a continuous sintered BeO_2 matrix and can is formed to enclose the fuel particles. The process may also be adopted to provide a continuous BeO_2 matrix between the particles and an unfuelled outer layer or can. It is preferable that the coating is sintered before loading the coated particles into the can, and the sintering may be effected under conditions such that the coating is appreciably porous so as to accommodate swelling of the fissile material during irradiation. On the other hand, the matrix and can materials can be so chosen and sintered as to obtain a density greater than 98% theoretical, and hence in effect form around each particle and around the fuel as a whole a dense impermeable BeO_2 skin which will prevent the escape of fission products. The fuel material is preferably a fissile or fertile oxide, although the process may be applied to carbides and nitrides. The fuel particles should be relatively large (150 to 250 μ), and the coating material should be in the form of a relatively fine powder, and may conveniently be mixed with wax prior to coating the fuel particles. It is convenient to form the unfueled can by slip casting and this technique can also be used to fill the interstices between the coated particles. The use of BeO_2 powder having a particle size distribution in the range 0.4 to 2.6 μ allows sintering to give 99% theoretical density. Methods for obtaining the BeO_2 powder are described. A fuel element comprising such material is also described. (UK)

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